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SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

Individualized and Vitalized Instruction in Teachers College Biology

Unified Curriculum in Science

A First Grade Science Activity with Shadows as Clocks and Calendars

Relative Effectiveness of Two Methods of Teaching General Science

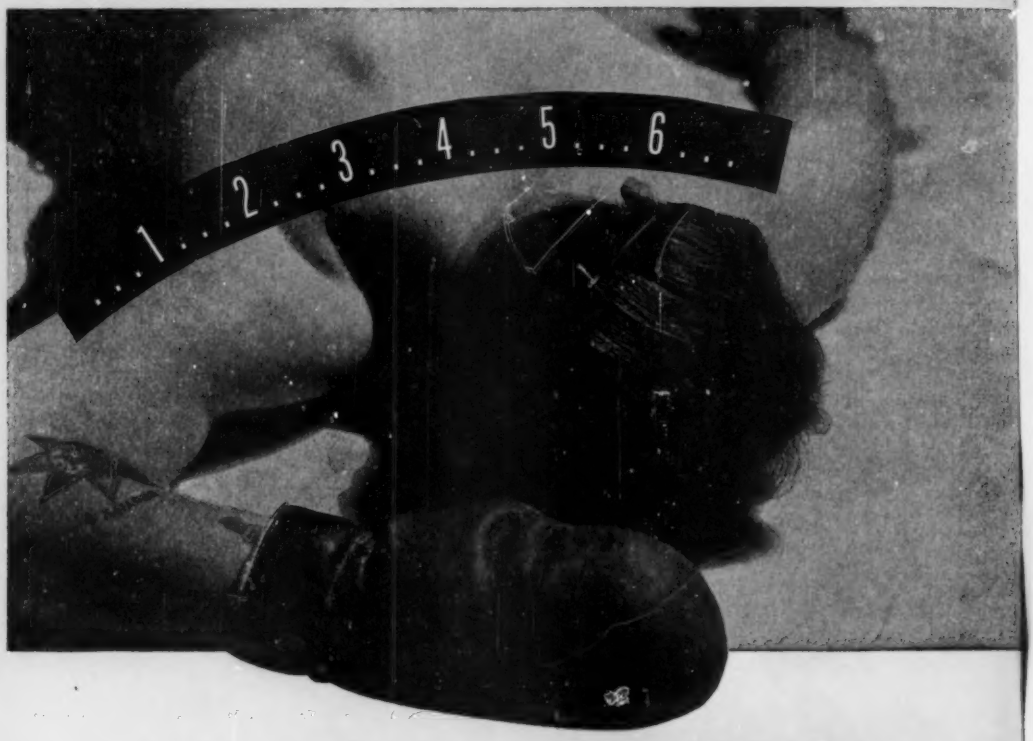
Regarding Attitudes in Science

Changing Conceptions of Teaching Helps in General Science Textbooks

Biology Enrollment and Curriculum Placement in California Schools

Student Investigation of Spiders

VOLUME 20
NUMBER 4
DECEMBER 1936



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Science Education

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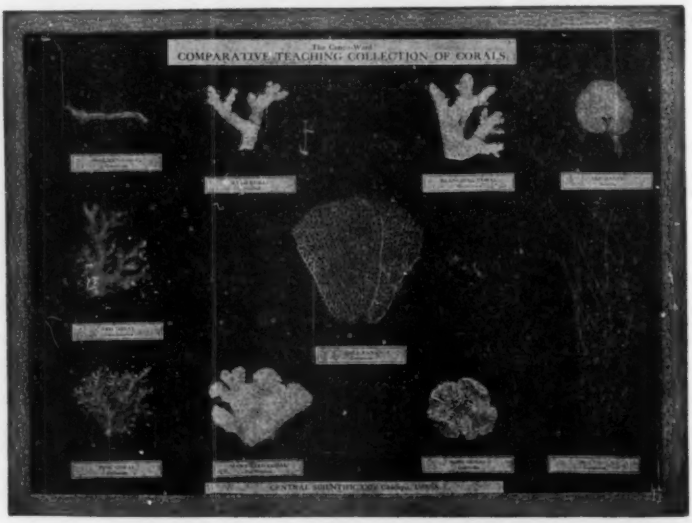

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Science Education

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 20 DECEMBER, 1936 Number 4

INDIVIDUALIZED AND VITALIZED INSTRUCTION IN BIOLOGY IN TEACHERS COLLEGE

FRED T. ULLRICH

State Teachers College, Platteville, Wis.

Each year, for the last few years, about 100 students in the different four-year courses in secondary, agricultural, and elementary education in the State Teachers College at Platteville, Wisconsin, have been receiving instruction in zoology in the first semester, and botany in the second semester in the freshman year. Four hours of credit are granted in each of these courses if the standards are met. Each of these courses requires four hours of recitation and two hours of laboratory instruction per week. Possibly the recitation and laboratory instruction is not different from that given in similar courses by other instructors, except as each instructor uses his individuality in his instruction.

However, there is an additional requirement that each student must meet if he is to be given full credit in these courses. Each student in zoology, likewise in botany, is required to bring to class some material from the environment which is a challenge to him, and possibly to the class, in understanding; or a verification of something that has been presented in the class. In addition, he must perform an individual project. If he is a member of the class in zoology, the materials brought in and the projects engaged in must consist of and deal with animal materials; while if he is a member of the class in botany, the materials must consist of and deal with plant materials. Before discussing the educational value of each of these requirements, it will be helpful to give illustrations of student performances that are acceptable. First, let us consider the materials that students may bring to class from the out-of-doors. In zoology the student may offer

amoebae or paramecia found in some of the pools of water in his surroundings; planaria found under rocks in springs; fossils of sponges, corals, snails, cephalopods, brachiopods, and trilobites found abundantly in the Trenton or Platteville limestone in the vicinity; scale insects that are encrusted on the twigs of the apple, slippery elm, and other trees; eggs, larvae, nymphs, cocoons, chrysalids, and adults of different insects; specimens of animals from ponds and streams other than those already mentioned, and dozens of other animal forms that may attract the attention of the student. In botany, students may offer representatives of the spring flora in the woodlands; a weathered leaf to show the skeletonized structure consisting of ribs and veins; twigs to show the different positions of buds; needles and scales from the different conifers in the community; representatives of the different algae, fungi, liverworts, mosses, scouring rushes, and ferns; the flowers and fruits of the different deciduous trees, *etcetera*. No contribution is accepted unless the student gives a clear statement as to the environmental conditions under which the material has been found, has definitely identified the material, and understands its relation to the organism of which it is a part, or if an entire organism, its relation to other organisms, and offers a satisfactory discussion of its significance in the affairs of man, if any.

I think we can all agree that one of the purposes of biological instruction is to illumine the environment for the student, to make it meaningful. We also know that animals and plants cannot be studied successfully from books alone, or even from preserved specimens in the laboratory. If an animal or plant is taken out of its natural habitat much that is important in the true understanding of the animal or plant is lost. We believe that the requirement to find the material in the environment, to think about it, and then to ask about it, establishes an attitude and habit of mind that is most essential for all those who are to develop a true appreciation of nature and nature's ways. In a sense, the procedure supplements in a most effective manner the objectives that are to be attained through field trips.

This requirement recognizes the fact that the learning of a principle and its application are different psychological processes. This may be illustrated through an experience from a field other than biology. Several decades ago when the writer was a student in the University of Chicago, he, with others, visited some of the classes in the Lane Technical High School in the city of Chicago. One of the classes visited was a class in pattern making. Some one asked whether or not the students in the course made use of any higher mathematics in the course. The instructor said they did. Then the question was asked if the students were required to take courses in higher mathematics as separate courses. The instructor responded, by saying that they were. But he added that these courses did not amount to much because he had to teach these students again all the higher mathematics that they needed in the course in pattern making. The answer of this instructor may not be entirely correct, but it does illustrate the fact that it is possible for students to learn things in a classroom without any attention to application; and then when the time comes for the application, the students are unaware that they have learned anything that is of use in the problem under consideration. Therefore, it seems reasonable to believe that this device of having students in zoology and botany bring from nature materials that have been discussed in class, or those that are a challenge to the understanding of the students will aid in having them carry the instruction in the classroom and laboratory to the out-of-doors where most animals and plants live and have their being.

There is another aspect to this type of instruction in a teachers college that should

receive some consideration. One of the propositions that has been discussed for the last two decades is the professionalization of subject matter. Without going into the proposition of what is and what is not meant by the professionalization of subject matter and then leaving all in somewhat nebulous condition, the writer quite dogmatically wishes to state that the teacher who professionalizes his subject matter is always conscious of the use the students are to make of the instruction that is given. If the prospective teachers of biology are trained to use the subject matter taught them, it is reasonable to suppose they will be disposed to have their boys and girls study animals and plants in their natural habitat instead of simply studying books and preserved materials. It is not to be implied that books, magazine articles, and laboratory materials should not be studied to gain an understanding of animals and plants, but it must be kept in mind that these studies are not an end in themselves but only a means to the end.

Let us now consider some of the individual projects in animal and plant studies that are and have been executed by students in zoology and botany. Some of the zoology projects are: (1) the culture of amoebae; (2) the culture of planaria; (3) the collection of planaria and their use in regeneration experiments; (4) a collection and identification of aquatic animals (limnology); (5) a collection and identification of harmful insects; (6) a collection and identification of the fishes found in the community; (7) a collection and identification of the amphibians in the community; (8) a collection and identification of the reptiles in the community; (9) the observation and identification of the land birds in the community; (10) the observation and identification of the water birds in the community; (11) a collection of insects and other animals to illustrate mimicry, protective coloration, warning colors, dimorphism, and similar phenomena; (12) the rearing of insects to illustrate different stages in the life history of an insect; (13) the skinning and mounting of a bird; (14) the preservation and mounting of the skeleton of a crayfish; (15) a clay model of an earthworm to show anatomical structure; (16) a collection of animal tracks transferred to a plaster of Paris plaque; (17) the rearing of walking sticks and demonstration of regeneration of lost parts; (18) a collection and identification of ancient animal life (fossils) in the community; (19) the making of lantern slides to illustrate animal structures; (20) a collection and identification of animal parasites; (21) a survey of the animal life in a specified area; (22) the identification of animal specimens in the college museum (different students are assigned to different groups of animals); etc.

Some of the botany projects are: (1) the growing of plants in an indoor garden, observation indicating how different plants escape from their seed coats; (2) demonstrations showing that some plants obtain their foodstuffs from the seeds; (3) a collection and identification of green algae; (4) a collection and identification of fungi; (5) a collection and identification of liverworts; (6) a collection and identification of mosses; (7) a collection of leaves of ferns and the identification of the plants of which they are a part; (8) a collection of leaves of the conifers and the identification of the trees from which they were taken; (9) a collection of twigs of deciduous trees, and the identification of these trees; (10) a collection of the leaves of the deciduous trees, and the identification of these trees; (11) the making of leaf prints; (12) clay models of cross-section of a leaf, and the lower surface of a geranium leaf (all parts much enlarged); (13) a collection and identification of fruits of trees (not the common fruits); (14) the growing of fern prothallia in the laboratory; (15) a collection and identification of the common lichens; (16) an investigation to discover the different plants that may come from a piece of solidly frozen surface soil from field or

woodlot; (17) a record of the first full display of flowers on the trees in the vicinity; (18) an exhibit to illustrate the different types of grafts, and some actual grafting on seedlings and trees with noted results; (19) a collection of specimens of the shrubs on the campus and the identification of plants from which the specimens were taken; (20) the tapping of hard maple trees for sap and the concentration of the sugar in the sap by boiling; (21) the growing indoors of flowering bulbs; (22) the setting up and maintenance of a balanced aquarium.

Many of these projects have been suggested by the leaflets published and distributed freely by the General Biological Supply House of Chicago. These service leaflets are drawn on largely by the students in the execution of the projects. At the beginning of each semester the lists of projects, animal projects in the first semester and plant projects in the second semester, are submitted to the students. The students are at liberty to select the particular projects that appeal to them within certain limits. An effort is made to persuade students to engage in as large a variety of projects as is feasible, considering the interests of students. It has been found that by having a large variety of projects, students learn from each other the possibilities and the techniques involved in projects other than those they select. After the students have selected these projects, they operate on their own initiative or responsibility. They know that the acceptable completion of the projects is required to obtain full credit. However, if the students desire help, the instructor is always ready to advise with them. The help that the instructor may give consists largely in directing the students to sources from which they may obtain suggestions for the execution of the project. Now and then the instructor may give a demonstration of a particularly difficult manipulation in the development of the project. In some instances students are required to write a project story after the completion of the project. In others, students need only to submit the finished concrete material.

The experience with students in the execution of these projects indicates that many of them have an initiative and a technical ability which would not be developed in the regular class room and laboratory instruction. In some instances, when students do an exceptional piece of work, as in the mounting of a bird skin or in the making of a plaque showing the tracks of animals, they are asked to give a class presentation of the steps followed, the difficulties they encountered, and the method of overcoming these difficulties in the execution of the project.

One of the established features of the State Teachers College at Platteville is an exhibit of the results of the work in the different classes. These exhibits are open to inspection by the public. It is of interest to note that the students in zoology and botany spend most of their time during the visits of the exhibit in hovering about the projects for which they are responsible. They consider these projects real achievements and are proud of their results. And after all, one of the greatest things that can be done for a student is to give him a real thrill in a field of subject matter that will enrich his life and through him the lives of others. It should be mentioned that these school exhibits are a biennial affair. Therefore during the years without school exhibits students display their results on some of the reading tables in the main room of the college library.

A UNIFIED SCIENCE CURRICULUM

VERNON HODGE

Manual Arts High School, Los Angeles

During the past three decades, science in the secondary schools has become more and more an integral part of the curriculum, until at the present time it has become, almost universally, a requirement for graduation. This increased emphasis has naturally resulted in a critical evaluation of both subject matter and teaching methods. There are many books and magazine articles available which cover various aspects of the field. It is significant that the general consensus of opinion of American investigators is that high school science courses are too narrow in scope, too technical in nature, and too highly specialized in content. Many writers are insisting that science work should be made more meaningful to the pupils and they have stressed the beneficial results obtained when such a meaningful and functional program has been developed.

Cursory reading in the field of educational literature on aims and objectives reflects the general prevalence of such terms as "Dynamic Curricula," "Emerging Civilization," and "Changing Social Order." Upon analysis these terms seem to point to the necessity of adjusting the content of the science courses to the functional needs of the pupils. Again, the terms, "Individual Deportment," "Social Urgency," "Company Living," "The Good Life," "Social Morality," "Integrated Personality," rest upon the recognition of the social emphasis which should permeate the entire curriculum and modern education.

The shift from the former emphasis on subject-matter content to the newer one of social responsibility and functional emphasis is most noticeable in the present-day literature as it pertains to the science curriculum. Recent statements of the aims of science instruction, emphasize particularly that it is desirable to give the pupil an understanding and appreciation of natural law, to acquaint the pupil with knowledge of the extent to which man may control his physical environment, and to afford such material as will be of useful vocational and avocational value.

To summarize: (a) modern educational theory insists that social implications inherent in the content of high school science be developed, (b) the aims of science teaching, as stated by modern educational authorities, are in accord with this philosophy, (c) there is a disparity between the modern educational theory which emphasizes social development and actual class practice which emphasizes factual and highly technical material.

This article is presented to suggest a science curriculum that may help to coordinate modern philosophy with actual classroom technique. It is based upon suggestions by modern educational authorities as they pertain to classroom procedure in the teaching of science in the secondary schools.

Many proposals for the reorganization of the science curriculum on the secondary school level have been made. The majority of these proposals center around reorganization of the course of study and merely suggest changes by eliminations and substitutions. However, to obtain the results desired, namely, functional carryover to the pupil's life activities and the development of a social awareness, it is necessary to reorganize completely the subject field of science instruction. In the social science field, the Report of the Commission on Social Studies recommends that the social sciences be taught as a phase of the single field, rather than as various traditional units of economics, sociology, history, and the like. There should be related se-

quences, and in these sequences, man should be considered the focal point. Related sequences of a similar nature for the science field have already been suggested by some educational authorities and experimental evidence indicates that successful results have been obtained from such an arrangement.

To facilitate the development of related units of work, no doubt certain guiding principles are necessary. Authorities appear to be in accord that the science curriculum of the secondary school should (a) provide a fused science sequence, (b) use the problems of man as the focal point, (c) place emphasis on the social implications of the field, and (d) make possible an extended use of supplementary reading materials, class reports, visual materials, individual rates of progress, and other modern teaching devices.

As a suggested science curriculum which reflects this point of view and which meets the requirements previously noted, the science sequence presented in the remaining paragraphs is offered. This work is arranged as a related sequence and is divided into three main topics, each topic representing a year's study. The material as presented is suggestive only and it is not intended for every student to cover all the ground. It is expected that the teacher will seize every opportunity to make the best use of individual progress rates, visual aids, library reports, field trips, *etcetera*.

The focal point of the work is man. The three divisions consider (1) The Ascent of Man; (2) Man's Relation to and His Control of His Natural Environment; (3) The Scientific Age: Nature in the Service of Mankind. These divisions are placed at the tenth, eleventh, and twelfth levels respectively.

1. *The Ascent of Man.* The outline suggests that the work start with hypotheses of world formation together with a study of the heavenly bodies. This material, which can be presented in popular form, and which has such an appeal to the pupil, will recall to them their ninth-grade general science and will provide an introduction in a field in which they may feel at ease. The outline next considers the age of the world, the five major eras of geological history and the contribution of each to show how the world prepared for the advent of man.

The study of how the world came to have its present geographical conditions is next taken up. It is the plan to show how changes in the surface of the earth have materially affected the life of man. Problems of the erosion of soil, dust storms and the like emphasize that everything man does is the effect of some cause.

The outline then provides for a brief view of the microscopic world and concludes with a consideration of man in his present state of development.

It will be recognized that many of the topics herein discussed are reminiscent of the pupil's ninth-grade general science. Such a set-up is deliberate, and provides for a greater articulation between the two grade levels. It is assumed that the student will be strengthened in this work by having studied some of the topics in the ninth grade and that this review, or rather new view, will be more meaningful because of the student's earlier experience. As a matter of fact the material herein presented for each of the three high school grades is connected through a spiral arrangement, touching the same fields again and again at different levels, and with each contact attempting to enlarge the horizon of the student as to the relation of science to life and to the life of mankind.

2. *Man's Relation to and His Control of His Natural Environment.* The work of the eleventh grade is built around the natural environment of man: the air, the water, and the earth, for which study material is drawn from the fields of physics and chemistry largely but taken when necessary from other fields as well. In every topic considered it is the plan to discuss fully the

social implications of the material and the result that its development has had upon mankind.

3. *The Scientific Age: Nature in the Service of Mankind.* The twelfth-grade work considers modern applications of scientific principles together with the changes their introduction have brought to mankind. It is proposed that much attention be given to this latter phase. The course closes with a consideration of some of the modern contributions of present-day scientists and of some problems yet unsolved.

4. *General Material.* An ungraded section is attached in which suggestions are made for material which may receive attention at any point in the course, the treatment to depend, of course, upon the level of the work, the student's background, and good reason for its injection into the work at a particular point.

GRADE X

THE ASCENT OF MAN

1. The preparation of the earth for the advent of man.
   - A. The hypotheses of world formation together with some elementary descriptive astronomy.
   - B. Establishment of a concept of time relations.
   - C. The five great ages and the major contribution of each.
2. Forces tending to change the earth's surface.
   - A. Consideration of topics such as: (a) erosion; (b) mountain building, and (c) earthquakes
   - B. How such changes affect man's life
3. The microscopic world: man's enemies and friends.
   - A. The amoeba, the paramecium and cellular structure together with methods of cell division.
   - B. Prehistoric life development as a gradual adaptation and evolution of unicellular life to multicellular organisms.
   - C. Man as an organization of simple cells.
   - D. Friendly microorganisms.
   - E. Enemy microorganisms.
4. Man in his present state of development.
   - A. Descriptive consideration of (a) the digestive system; (b) the nervous system; (c) reproduction (tied up with 3A and 3B) with some elementary consideration of the field of eugenics; (d) effects of alcohol and narcotics (descriptive and general), and (e) food, food values, diet.

GRADE XI

MAN'S RELATION TO AND HIS CONTROL OF HIS NATURAL ENVIRONMENT

1. The air.
   - A. Weather forecasting.
     - a. Meteorology, airplane piloting, *etcetera.*
   - B. The composition of the air.
     - a. Concepts of mixtures, compounds, molecules, combustion, elements, atoms.
     - b. Oxygen, the vital element in the air.
       - (1) Historical background, modern laboratory and commercial methods, uses.
       - (2) Combustion, oxidation, valence, symbols.
       - (3) Breathing, the C cycle.
     - c. Nitrogen, the inert element.
       - (1) Fertilizers.
       - (2) Explosives.
         - (a) As helps to mankind.
         - (b) War—a perversion of science.
     - d. Other substances present in the air.
   - C. The air at work.
     - a. Pneumatic appliances, airships.
2. Water.
   - A. The composition of water.
     - a. Concepts of reactions, equations, acids, bases, neutralization.
   - B. Water in the service of man.
     - a. Water in the body, osmosis, the body cooling system.
     - b. Hard and soft water, together with the economic implications.
     - c. The geology of water.
     - d. Buoyancy, specific gravity, *etcetera,* and the uses of these concepts.
3. The earth.
   - A. Minerals, their distribution and their chemistry.
     - a. The distribution of minerals and ores as a cause for migrations, wars, commercial rivalry, *etcetera.*
     - b. The chemistry of the composition of ores, and their refining.
     - c. The products of the earth.
       - (1) Plants, their structure, propagation, classification, *etcetera.*
4. Our bodies and how to care for them.
   - A. The digestive system viewed as a chemical process.
   - B. The nervous system with reference to psychological aspects, and the autonomic system.
   - C. The reproductive processes with special attention to the fields of eugenics, Mendel's Law, the Kallikak and Dalton studies, legislative phases, *etcetera.*

D. The effects of alcohol and narcotics viewed with a background of chemistry, physics, and biology.
E. Food chemistry.

GRADE XII

The Scientific Age: Nature in the Service of Man

1. Electricity as the servant of man.
   A. How electrical devices operate, and the basic principles involved.
      a. Social developments resulting from such devices as the incandescent lamp, radio, *etcetera*.
   B. A consideration of some still unsolved problems.
2. Heat as a servant of man.
   A. Problems and appliances connected with radiation, conduction, and convection; mechanical refrigeration, air conditioning.
      a. Social problems resulting from developments in this field.
3. Light as a servant of man.
   A. Theories as to the nature of light.
   B. Optical instruments, including the eye and care of same.
   C. Sociological problems resulting from optical machines such as the camera, the movie, *etcetera*.
   D. Photosynthesis.
4. Other forces at work.
   A. The physics of sound and sound devices, including the ear.
      a. Sociological problems arising from sound devices.
   B. Levers and their applications.
   C. Magnetic devices and their operation.
5. Recent development and future problems.
   A. The chemistry and manufacture of rubber, glass, synthetic foodstuffs, perfumes, *etcetera*.
   B. Modern research and its contributions.
      a. Cellophane, bakelite, aspirin, adrenalin, hexylresorcinol, modern anesthetics, *etcetera*.
   C. The ductless glands.
   D. Alloys.
   E. Elimination of economic waste.

General Material

1. Man's present stage of development.
   A. The history of science, superstitions, alchemy, old ideas of medicines, *etcetera*.
      a. Great scientists and their contributions.
      b. The struggle of science against the inertia and opposition of mankind.
      c. The martyrs of science.
   B. The scientific process, what constitutes a fact, a theory, an hypothesis.
   C. Consumer education.
      a. Advertising.
      b. Quack remedies.
      c. Money values.
   D. Investigation of modern civic and social problems through the scientific method and a discussion of the findings.
   E. Other similar or pertinent topics.

SHADOWS ARE LIKE CLOCKS AND CALENDARS

Mary L. Garvey
First Grade Teacher, Fuller School, Minneapolis, Minnesota

The sun was shining. Shadows were in our room. They differed in shape, size and color. There was the little irregular shadow of the plant on the windowsill and the larger shadow of the child which followed him as he moved about the room, flickering shadows of the leaves on the trees outside the window and the fixed and regular shadows of the window frames. There were so many things we wished to know that we went outdoors to learn. A cloud partially covered the sun, shadows became faint, and then there were none.

It was from these varied experiences on bright and sunny days in our room, on excursions, and in our school garden, that our shadow unit was initiated. We endeavored to simplify learning situations by drawing upon a large number of experiences and making use of many kinds of learning devices such as picture study and experimentation with shadow objects. It was hoped that desire for learning might be aroused within the children and at the same time they could be given a feeling of satisfaction because of completeness of experience.

From September to December we took many morning, noon, and afternoon excursions, having definite objectives in mind.

We worked in our garden picking our vegetables, flowers and seeds, and getting the ground cleared for winter. During these activities our attention was drawn to the many shadows around us and to their various shapes and sizes. We found whenever the sun was in the southeast, all the shadows (trees, garden fence, schoolhouse, garage, and our own shadows) pointed northwest. From these observations sentences like the following were written:

The morning sun is in the Southeast.
All morning shadows point Northwest.
The morning shadows are very long.
The shadow is on one side of the object and the sun is on the other.

We recorded our findings in a similar manner for our noon and afternoon experiences. The shadows of many children were measured by using a cord. We tried to draw lines as long as these shadows on the blackboard or on a scroll, but we found some of them too long. We chose to measure the smallest child in our room and keep her shadow record, because we could draw a line as long as her shadow on the board. Her shadow was measured once a month, and a room record in colored chalk was kept. (A different color was used for each month.)

Six-year old children are naturally active and eagerly alert for new experiences. The work was planned with the purpose of sharpening the powers of observation, encouraging experimentation and building the habit of drawing conclusions as a result of the observation and experimental activities.

The line of our shadow record grew longer each month. We could see that all shadows were growing longer. This aroused "Why" questions. We discovered that the days were growing shorter as can be seen from the following remarks:

In September it was daylight when we ate our breakfast.
We needed to have lights on when we ate breakfast in December.
We played out of doors after dinner in September.
It was too dark and cold to play out of doors after dinner in December.

From these findings some understanding was gained of the fact *"as the days grow shorter the shadows grow longer."*

Illustrations of shadow pictures, games, number experiences and original rhymes resulted. The following pages give the experiences of the children in their activities and show more clearly how our reading, language, science, art, and number work centered about our interest in shadows. Some of our original rhymes are as follows:

My shadow goes here and there
It follows me everywhere.

My shadow stands still
When I stand on a hill.

It is fun
To make my shadow run.

My three shadows every day
(meaning morning, noon, and afternoon shadows)
Always point in a different way.

I can touch my shadow's head
When I lie as I do in bed.

When I jump my shadow jumps,
When I run my shadow runs.

There was a little shadow
It could jump and run and play.
It seemed very, very lonesome,
It stayed by me all day.

The children cut pictures of shadows out of magazines, brought kodak pictures of themselves and their families. They drew numerous illustrations. They became shadow conscious. This illustrative material indicated the children's interpretation of their observations relative to the position of sun and shadows. They were measures of understanding.

Nearly all of us knew Stevenson's poem, "I Have a Little Shadow." We wondered if we could find other poems about shadows. The librarian assisted us in finding many. These poems were read and re-read to the children. Some were asked for again and

again. We had our favorite poems typed. These were read and re-read as often as the children asked for them. Great enjoyment and appreciation was expressed in the reading of the following poems:

1. *Little Folk Lyrics*—Sherman.
   a. The Shadows.
   b. Shadow Children.
   c. Ghost Fairies.
   d. Shadow Pictures.
2. *Silver Pennies*—Thompson.
   a. The Night Was Creeping on the Ground.
   b. The Shadow People.
3. "I Have a Little Shadow"—Stevenson.
4. "Two Little Shadows"—Merryman.

Number experiences entered this work in the following way:

1. A group of children took an excursion today. They reported finding shadows of six different objects.
2. Another group saw ten different shadows yesterday. Which group found the more shadows? How many more?
3. The third day the children could not find shadows. Why? (a dark day). From experience all children knew that there are no shadows on dark days.
4. Four of the boys had very long shadows. Why? (They were very tall). Two girls had very long shadows. Why? How many more boys than girls had very long shadows?
5. Six girls had very short shadows. Two boys had very short shadows. How many children had very short shadows? How many more girls than boys had very short shadows?

The following pages illustrate some of the records kept by the group:

Our Shadows

We went out to look for shadows.
We found shadows in the morning, at noon, and in the afternoon when the sun was shining.
The sun makes shadows.
Morning and afternoon shadows are long shadows.
We call them slanting shadows. (Meaning that they do not point directly east, north or west).
Noon shadows are short shadows.
We call these straight shadows. (They point directly north).
Shadows are like clocks.
They tell the time of day.
We tell time by the clock.
We tell time by the sundial on our building.
We watch the shadow move on the sundial.

Morning Shadows

Our morning shadows were long and pointed toward the Northwest.
The sun was in the Southeast.
We looked to see how many shadows we could find.
The fence's morning shadow pointed Northwest.
Some of the children found the tip of the garage. It pointed Northwest.
The schoolhouse shadow was very large.
It pointed Northwest.
All the morning shadows we found pointed Northwest.
Our shadows could run, jump and stand still.
Some of us could touch the heads of our shadows.

Noon Shadows

Our noon shadows were short.
They were almost our own size.
They looked more like us.
They pointed straight North.
All noon shadows pointed North. (Fence, trees, schoolhouse).
We called these straight shadows.
We said noon shadows show a real picture. (Meaning the shadow looks like the object).

Afternoon Shadows

These shadows were very long.
They pointed toward the Northeast.
The sun was in the Southwest.
We found so many different shadows.
The shadows of the leaves moved.
The shadows of our hair and dresses moved.
The wind was blowing.
The schoolhouse shadow did not move.
It was very big.
All the afternoon shadows pointed toward the Northeast.
It was fun to look for shadows.

We learned the names of the months and noticed particularly the changes which had taken place in nature from month to month. The following reports illustrate the applications of learning made by the children:

September

The September days are long.
Some of us go swimming after school.
The trees have green leaves.
Shadows of objects and children are long.

October

The leaves are yellow, orange, red and brown.
The leaves are falling from the trees.
The days are cool.
The shadows are longer than the September shadows.

November

The leaves are all off the trees.
We had two snow storms this month.
Our calendar record shows this.
Now we have lights on when we eat dinner and breakfast.
The shadows of objects and children are very long.

December

December is a winter month.
The ground is covered with snow.
It is very cold.
The days are very short.
We wear overshoes and warm coats to school.
The shadows of objects and children are very, very long.

Our Room Calendar

Our calendar tells the months of the year.
We keep a record of the weather on our calendar each month.
December is a winter month.
We know winter because the shadows are longer.
We can tell the time of the year by shadows.

Our study about shadows led to the emergence of many ideas, among which were:

All morning shadows point Northwest.
The sun is always in the Southeast.
These shadows are very long.
All noon shadows point North.
They are short shadows.
All afternoon shadows point Northeast.
The sun is always in the Southwest.
These shadows are very long.

Observations from September to December

Our shadows are growing longer.
Our days are growing shorter.
Our December shadows are the longest.
Our September shadows are the shortest.
Shadows grow longer as days grow shorter.
Shadows grow longer as winter comes.

The second semester some 1B children were added to the 1A group. We proceeded with our shadow work. The first record taken with the 1B and 1A group indicated that the shadows were growing shorter. We knew the days were growing longer. The 1A children were thrilled with the new findings. They wondered if the shadows would continue growing shorter. To find the answer to this question we decided to measure the same shadow once each month.

It was interesting and enlightening to watch the reactions of the two groups to the experiment. Some of the 1B children appeared to be following understandingly, some evidenced bewilderment. One child with a high I.Q., who to all appearance was following closely, said, "Well, what is it all about?" This remark showed confusion in her mind. It also proved that learning and clear understanding relative to the study of *sun* and *shadows* had taken place during the first semester. It was evident that the new group would require special attention not only in this situation, but in all of their work.

It pointed out very clearly to the teacher that subject matter cannot be thrust upon children without first giving them a background of varied experiences and creating in them a desire for learning.

A COMPARISON OF THE RELATIVE EFFECTIVENESS OF TWO METHODS OF TEACHING GENERAL SCIENCE

J. DARRELL BARNARD
Colorado State College of Education
M. L. ROBERTSON
New York University

PROBLEM

The purpose of this investigation is to compare the relative effectiveness of a "teacher-prepared study guide" method and a "pupil-developed study guide" method of teaching general science with respect to both immediate and delayed reaction to "paper and pencil" tests.

This study deals only with the two experimental factors named. It is in no way concerned with the type of subject matter, the arrangement of the content into units, the grade level of the content, or a comparison of the three types of test items used.

METHOD

Two classes in the Ault Consolidated School and two in the Laboratory School of Colorado State College of Education* were selected to serve as two pairs of experimental groups. Due to the presence of pupils who presented uncontrolled irregularities, the groups were equated separately for each of the nine units and again at the close of the study. The groups were equated both on the basis of the scores obtained on the Van Wagenen Reading Scales in General Science[1] and the scores obtained on pretests over the nine units of science used in this study.

Tables I and II indicate the degree of equivalence secured by the two bases of pairing for each of the nine units.†

Two major units of science that had previously been found suitable for these levels were deemed appropriate for this experiment. One dealt with physical science and one with biological science. The first of the two large units was divided into the following four subsidiary unit problems: (1) What forces are building up the surface of the earth? (2) What forces are wearing down the surface of the earth? (3) How do crustal movements of the earth change its characteristics? (4) How do living organisms change the surface of the earth?

The second of the two units was divided into the following subsidiary unit problems: (5) What interdependences exist between green plants and other organisms? (6) How are symbiotic organisms benefited by living together? (7) What relationships exist between parasitic organisms and their hosts? (8) How are members of the animal kingdom benefited by living a communal life? (9) How is the balance of nature maintained?

* Miss Gretchen McClaskey assisted the experiment in these classes.

[1] Van Wagenen, M. F., *Reading Scales in General Science Scale A and B.* Bloomington, Illinois: Public School Publishing Company, 1921.

† The groups were considered to be equivalent when the difference of their means divided by the standard deviation of their means was less than one. The standard deviation of the differences of the means was computed from the following partial formula:[2]

$$SDD_m = \frac{M_1 - M_2}{\sqrt{\left(\frac{SD_1}{\sqrt{N_1}}\right)^2 + \left(\frac{SD_2}{\sqrt{N_2}}\right)^2}}$$

It will be observed that in no case was this quotient greater than .92.

[2] Garrett, H. E. *Statistics in Psychology and Education.* New York: Longmans, Green and Company, 1926. p. 133.

These unit problems were constructed around major and subsidiary principles without reference to a particular text. It became necessary, therefore, to select from several sources material that contained all the information necessary to solve any one of the problems. This material was prepared in two mimeographed booklets.

Two techniques were used to guide the pupils in obtaining an understanding of these unit problems, a "teacher-prepared study guide"* and a "pupil-developed study guide" method.

Prior to the experiment it was necessary to give each pupil practice in the techniques involved in the two methods. Ten weeks were spent in all four classes on two units practicing the development of study guides. The study guides were first prepared by one of the writers. The unit problem, after careful consideration, was divided into several smaller or subsidiary problems upon the basis of the following criteria:

(a) Each problem when solved must contribute to the solution of the unit problem
(b) Each problem must develop one idea
(c) The problems should be arranged in a definite order
(d) The problem should be stated clearly and concisely

Under each of the subsidiary problems were listed questions to answer and activities to perform which, if understood, would solve the problem.

At the end of each subsidiary problem, provision was made for summarizing into one large concept those ideas built up by answering the questions and performing

TABLE I

DEGREE OF EQUIVALENCE OBTAINED ON THE BASIS OF READING ABILITY

Unit	*Group*	*No. of Pupils*	*Mean Score of Reading Ability*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$	*Unit*	*Group*	*No. of Pupils*	*Mean Score of Reading Ability*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
I	A	26	77.03	6.76	−.10	I	C	26	79.30	6.45	.55
	B	24	77.25	7.95			D	19	78.31	5.64	
II	A	28	77.64	6.88	.13	II	C	27	79.70	7.47	.07
	B	22	77.27	7.96			D	22	79.54	6.08	
III	A	21	78.38	6.60	.69	III	C	25	79.44	6.62	−.47
	B	20	76.65	8.03			D	24	80.29	5.86	
IV	A	27	76.96	6.94	−.44	IV	C	28	80.71	6.33	−.72
	B	23	77.86	7.33			D	33	82.00	6.66	
V	A	18	78.50	7.08	.40	V	C	25	80.62	3.56	0.00
	B	18	77.40	8.65			D	25	80.82	3.52	
VI	A	25	76.88	8.64	−.38	VI	C	24	79.54	6.88	−.26
	B	28	77.60	8.79			D	22	80.00	4.64	
VII	A	18	77.72	7.39	.45	VII	C	30	79.70	3.46	−.37
	B	20	76.65	8.44			D	29	80.00	7.24	
VIII	A	22	78.45	7.33	.05	VIII	C	25	79.88	7.24	.20
	B	22	78.31	8.81			D	34	79.41	7.29	
IX	A	23	77.82	6.68	.04	IX	C	23	80.82	8.01	−.10
	B	18	77.77	9.10			D	21	81.23	4.85	

* The term "study guide" as used in this investigation was defined as consisting of a series of problems to be answered and a list of activities to be performed, the execution of which solves the unit problem for which the study guide was made.

the activities. At the end of each guide sheet further provision was made for summarizing the subsidiary concepts into one major concept.

The pupils were first taught to recognize problems through the medium of carefully planned lessons involving situations from which they were to derive problems in the form of questions. The problem must be so worded that the answer would clarify the situation. Later two consecutive study guides were developed under the direction of the teachers. The entire class was encouraged, by directed questions to recognize and state the questions and activities necessary to the solution of the two unit problems, "What effect has the changing environment upon those organisms which are unfitted to it?" and "How was the earth formed?" Each pupil evaluated his problems and activities on the basis of criteria similar to the four used by the teachers.

To insure identity of training, the preliminary experiment was begun at Ault a week in advance and a competent stenographer secured a word for word record of each class period. This material was transcribed daily and was subsequently used as an outline in the Laboratory School classes.

After a study guide was made for a unit, the class solved the problems by engaging in one or more of the following activities:

a. Reading books, magazine articles, and other printed information
b. Observing phenomena
c. Interviewing or asking questions
d. Observing graphs, charts, tables, diagrams and pictures
e. Experimenting

Tests similar to those to be used in the experiment were given before and after each of the preliminary units studied.

With each method the teacher introduced the unit with an oral preview. The group working with the "pupil-developed study

TABLE II

Degree of Equivalence Obtained on the Basis of Pretests

Unit	*Group*	*No. of Pupils*	*Mean Score of Initial Test*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$	*Unit*	*Group*	*No. of Pupils*	*Mean Score of Initial Test*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
I	A	26	40.76	5.00	−.55	I	C	26	40.92	4.15	.15
	B	24	41.50	4.46			D	19	40.75	3.83	
II	A	28	43.10	4.22	−.77	II	C	27	44.11	3.62	−.54
	B	22	44.50	7.60			D	22	44.72	3.46	
III	A	21	45.14	4.39	−.39	III	C	25	43.80	5.05	.00
	B	20	45.65	3.81			D	24	43.79	3.84	
IV	A	27	31.25	2.70	−.81	IV	C	28	53.00	2.56	.74
	B	23	32.17	4.03			D	30	32.53	2.25	
V	A	18	37.22	4.25	−.54	V	C	25	38.20	2.78	−.66
	B	18	37.88	3.12			D	25	38.68	2.53	
VI	A	25	27.72	3.09	−.64	VI	C	24	24.20	2.65	−.92
	B	26	24.25	2.90			D	22	24.95	2.93	
VII	A	18	35.66	4.18	.08	VII	C	20	37.96	5.60	.10
	B	20	35.55	4.24			D	29	37.86	3.51	
VIII	A	22	30.31	2.84	.43	VIII	C	25	31.00	2.85	−.17
	B	22	30.81	4.60			D	34	31.11	3.17	
IX	A	23	38.70	3.46	−.03	IX	C	23	39.30	4.02	−.59
	B	18	37.05	3.39			D	21	40.05	4.51	

guide" method would then proceed to make their own study guide by group discussion in which the teacher participated. Care was taken to insure that all the fundamental elements of the "teacher-prepared study guides" were included. These pupils then proceeded to answer the questions and perform the activities involved. The group working with the "teacher-prepared study guide" method was given a prepared mimeographed guide sheet upon which they immediately began working. In both groups each pupil wrote out and handed in a solution of the problem for each unit.

The tests used in this investigation were objective and were composed of about fifty items per unit. Three types of items were used.

The first part of each test involved the ability of the pupil to pick out true statements which applied to the generalizations developed in the unit. The second part of each test involved the elements of problem solving.[1] The third part of the test consisted of situations involving scientific attitudes.[2] There was a total of 466 items in the nine unit tests. Each unit test was administered to the groups before the period of instruction. It was repeated at the close of the period of instruction to test for immediate outcomes and again, eight weeks later, for the purpose of measuring retention.

In this investigation 140 general science pupils in four classes were used. The experiment was continued for nine weeks, one pair of groups devoting five forty-five minute periods a week and the other pair five fifty-minute periods a week to the study of science.

The following factors were kept identical for each pair of groups: (1) the text material, (2) the teacher, (3) the length of period, (4) the date upon which a particular unit was presented, (5) the preview, (6) the tests, and (7) the room and equipment for experimenting.

All of the materials used by the experimental groups was kept in the classroom. All guide sheets, papers and reference materials were passed out and collected daily. Care was also taken to insure that all the items covered in the tests were included in the units.

The rotation method of experimentation was used in accordance with which each group studied successive units by each method in turn. Groups B and D studied Units I, III, V, VII, and IX by the "pupil-developed study guide" method and Units II, IV, VI, and VIII by the "teacher-prepared study guide" method while groups A and C studied Units I, III, V, VII, and IX by the "teacher-prepared study guide" method and Units II, IV, VI, and VIII by the "pupil-developed study guide" method. The method was so rotated that the same unit was presented on the same day under the two experimental factors. The effectiveness of instruction by each method was determined for each separate unit, both for immediate learning and retention, by averaging the change in score produced by that method upon the unit test. The comparative effectiveness was determined by the difference in mean gains secured under the two methods. The significance of the results in each case was determined by dividing the difference of the means by the S.D. of the difference in means.[1] Tables III and IV indicate the relative efficiency of these two methods as indicated by these tests.

FINDINGS

An examination of Table III indicates that in fourteen of the eighteen cases such

[1] Hunter, G. W. *Science Teaching at Junior and Senior High School Levels*, Chicago: American Book Company, 1934. Pp. 211–212.

[2] Powers, S. R. (Chairman). *A Program for Teaching Science*. Thirty-First Yearbook, Part I, National Society for the Study of Education. Bloomington, Illinois: Public School Publishing Company, 1932.

[1] Garrett, H. E. *Statistics in Psychology and Education*, New York: Longmans, Green and Company, 1926. p. 133.

TABLE III

COMPARISON OF THE RESULTS WITH RESPECT TO GROWTH IN ATTITUDES, PROBLEM SOLVING, AND APPLICATION OF GENERALIZATIONS AT THE CLOSE OF THE PERIOD OF INSTRUCTION

Unit	*Group*	*No. of Pupils*	*Mean Change*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$	*E.F.*	*Unit*	*Group*	*No. of Pupils*	*Mean Change*	*S.D.*	$\frac{M_1 - M_2}{SDD_m}$	*E.F.*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
I	A	26	2.69	3.84	−1.95	S.D.S.G.[a]	I	C	26	3.11	5.64	−.73	S.D.S.G.
	B	24	4.83	4.10				D	19	4.31	5.12		
II	A	28	1.78	3.09	.011	S.D.S.G.	II	C	27	1.14	3.84	−.17	T.P.S.G.[b]
	B	22	1.77	4.44				D	22	1.27	3.62		
III	A	21	2.57	4.33	.09	T.P.S.G.	III	C	25	3.04	4.55	−1.15	S.D.S.G.
	B	20	2.45	3.98				D	24	4.58	4.70		
IV	A	27	2.96	2.43	.52	S.D.S.G.	IV	C	30	3.16	2.58	3.01	S.D.S.G.
	B	23	2.56	3.69				D	28	.85	3.21		
V	A	18	0.61	4.39	−1.33	S.D.S.G.	V	C	25	2.08	1.36	−1.80	S.D.S.G.
	B	18	2.44	4.02				D	25	2.64	.99		
VI	A	28	1.28	2.85	−.58	T.P.S.G.	VI	C	24	2.29	4.12	−.10	T.P.S.G.
	B	28	1.78	3.43				D	22	2.40	3.90		
VII	A	18	−.22	4.07	−4.79	S.D.S.G.	VII	C	30	.63	5.25	−3.41	S.D.S.G.
	B	20	5.35	2.92				D	29	3.93	3.15		
VIII	A	22	3.18	4.15	1.65	S.D.S.G.	VIII	C	34	2.58	3.86	1.47	S.D.S.G.
	B	22	1.04	3.35				D	25	1.20	3.34		
IX	A	23	1.08	1.01	−3.13	S.D.S.G.	IX	C	23	1.65	4.52	−.37	S.D.S.G.
	B	18	6.68	2.58				D	21	2.38	4.76		

[a] "Student-developed study guide" method.
[b] "Teacher-prepared study guide" method.

TABLE IV

A Comparison of the Relative Efficiency of Two Methods of Teaching Science as Indicated by a Delayed Test

Unit	Group	No. of Pupils	Mean Change	S.D.	$\frac{M_1 - M_2}{SDD_m}$	E.F.	Unit	Group	No. of Pupils	Mean Change	S.D.	$\frac{M_1 - M_2}{SDD_m}$	E.F.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	A	23	3.00	5.10	−.47	S.D.S.G.[a]	I	C	26	4.88	5.11	.14	T.P.S.G.[b]
	B	22	3.72	5.17				D	19	4.75	4.40		
II	A	21	2.66	3.78	.51	S.D.S.G.	II	C	27	3.29	5.04	.92	S.D.S.G.
	B	18	1.77	6.49				D	22	2.09	3.75		
III	A	18	0.22	5.15	−2.44	S.D.S.G.	III	C	25	2.04	5.44	−1.53	S.D.S.G.
	B	17	4.76	5.79				D	24	4.33	5.11		
IV	A	25	2.04	3.75	.30	S.D.S.G.	IV	C	27	2.33	2.33	.63	S.D.S.G.
	B	21	1.72	3.44				D	28	1.89	2.82		
V	A	16	3.25	4.02	1.4	T.P.S.G.	V	C	23	2.95	3.48	−1.44	S.D.S.G.
	B	16	1.12	4.46				D	25	4.40	3.74		
VI	A	25	2.56	2.99	−.65	T.P.S.G.	VI	C	24	2.95	3.45	−.56	T.P.S.G.
	B	25	3.16	3.51				D	22	3.54	3.46		
VII	A	17	1.05	5.02	−1.41	S.D.S.G.	VII	C	29	1.69	4.53	−1.27	S.D.S.G.
	B	18	2.50	3.10				D	28	3.14	4.26		
VIII	A	20	3.45	3.75	.97	S.D.S.G.	VIII	C	25	1.20	3.89	−1.71	T.P.S.G.
	B	21	2.49	2.83				D	34	2.90	3.94		
IX	A	22	2.13	5.48	.41	T.P.S.G.	IX	C	22	3.36	4.88	−.62	S.D.S.G.
	B	17	1.52	3.60				D	21	4.28	4.06		

[a] "Student-developed study guide" method.
[b] "Teacher-prepared study guide" method.

advantages as were revealed by the test of immediate learning were in favor of the "pupil-developed study guide" method. In four of these cases the results are statistically significant. In all the others the quotient obtained by dividing the difference in means by the S.D. of the difference in means was less than three.

It will be noted in Table IV that twelve of the eighteen cases gave results, as measured by the tests used, in favor of the "pupil-developed study guide" method. None of these results are statistically significant, however.

CONCLUSIONS

In the light of the data secured in this investigation the following conclusions seem reasonable and justifiable:

1. This "pupil-developed study guide" method has some advantages over this "teacher-prepared study guide" method with respect to gains upon both immediate and delayed tests composed of items involving scientific attitudes, problem solving and application of generalizations though the results in general are not statistically significant.
2. When economy of time is considered those pupils working with this "pupil-developed study guide" method spent less actual time in solving the problems on their study guides and secured better results than did those pupils working with this "teacher-prepared study guide" method.

IMPLICATIONS

This study may be interpreted to suggest that a relationship exists between the amount of pupil participation in the organization of study guides and learning activities and the amount of growth in the abilities measured by these "paper and pencil" tests. It should be remembered also that this "pupil-developed study guide" method obtained whatever advantages are inherent in directed oral discussion which this "teacher-prepared study guide" method did not afford. It must be recognized that tests of the nature described in this study are not available in valid form. Much thought needs to be given to the development of testing techniques capable of adequately measuring skills in problem solving and the ability to apply generalizations.

Insofar as the results of this study may be accepted, it suggests one technique whereby pupils may effectively practice "self-education." It should therefore be one more string for the bow of the good teacher.

REGARDING ATTITUDES*

OTIS W. CALDWELL
General Secretary, A.A.A.S., Boyce Thompson Institute, Yonkers, New York

Joseph Henry is regarded as one of the founders of American science. During more than half of the 19th Century he was a leader in interpretation of natural phenomena. Morse's invention of the telegraph instrument had its origin in Henry's experiments performed while he was an academy teacher at Albany, New York. Henry had used an armature in experiments with electromagnetic signals, and Morse used these basic studies in his great invention. Joseph Henry also preceded Michael Faraday in discovering electric magnetic induction, and he and Faraday independently but almost simultaneously announced their discovery of the principles of electromagnets. Other important discoveries basic to modern scientific research were made by Joseph Henry.

But in early school work Henry was regarded as a dull boy. He was advised not to attempt any scholarly endeavors, but rather to seek training in one of the mechanical trades. At sixteen years of age, during a brief illness, he read a book on natural history, and his many inquiries about why things occur as they do made it evident that he had unusually keen observation and insight. He may have been dull in memoriter and rote performances, but he possessed an attitude of persistently looking for facts and for their meaning. The records give no clue as to the beginnings of this attitude which led Joseph Henry to successful research and teaching, to become Princeton's and the country's outstanding Professor of Physics, and then to be the one charged with organization and development of the Smithsonian Institution of Washington.

* Presented before the National Council on Elementary Science, St. Louis, Feb. 22, 1936.

Many men, who as adults became great scientists, were, like Henry, regarded as dull during their school days, yet they are known to have possessed attitudes of fact finding, of fact interpreting, and of unyielding curiosity to know the truth of things. Agassiz was an adventurous nuisance in his earlier schools. Darwin, a dud as a schoolboy, was sent here and there to school, and in his late youth was even sent to a theological school in his family's effort to maintain scholarly and social respectability. Pasteur was by no means an outstanding pupil until almost full grown. The list of so-called dull boys might be greatly lengthened. Indeed, so many men of genius were known as dullards in conventional school work of their their early years, that many parents have cherished the hope that their dull children are, by the very token of dullness assured of later success. There is no evidence, however, that dullness is in itself an exponent of later successes.

Lest there be misunderstanding, we should call attention to the larger number of scientists who are excellent students throughout their entire school careers in all subjects, including science. The school and college days of Asa Gray, George E. Hale, Robert Millikan, the Comptons, and a host of other outstanding characters, disprove the claim that early inefficiency, irregularity or eccentricity are precedents of later success in science. But the scientific attitudes which existed or were developed in all such men are the essential qualities.

Biographers of great scientists have constantly cited certain commended attitudes of their characters. If we but knew how these attitudes originated, how they were retained and developed, we might perhaps find some

way to increase their frequency. We cannot even be too certain as to just what the alleged attitudes were since the historian may have stressed unduly certain attitudes which appeared after the man's achievements became a matter of record. A good deal of biographical history may have been "thought up," after greatness was achieved. The Joseph Henry illustration is used not only to refer to the alleged attitudes, but to suggest how little has been recorded in any scientific fashion regarding the personal inclinations which are said to have produced highly important results. Even the common practice of having a scientist introspect and then report his own early compelling attitudes is open to question. For example, one great scientist has said that his success as a worker is due to the habit of accuracy which he derived from study of the classical languages. Another has credited his scientific success to his mother's habit of always taking seriously his boyish experimental and didactic efforts to make discoveries. These may have been factors but the claims are tolerated not because they are proved but because they fall in a field in which there is as yet little exact knowledge. Such claims cannot be proved nor disproved until much more is known than is now available. Whether good science work is caused by possession of scientific attitudes, or whether scientific attitudes result from science work, or whether both develop together needs to be found out. The situation reminds one of a New Hampshire native who in springtime looks at Mount Washington and says, "Well, we won't get any warm weather till the snow gets off the mountain, and the snow won't get off the mountain till we get some warm weather."

Falling into the same category is the frequent assertion that scientific attitudes are developed concomitantly with engagement in scientific work. This has not been proved. The sometimes ludicrous opinions of really great scientists when in fields beside their own, do not show that these scientists have acquired generalized attitudes. The evidence indicates that their scientific attitudes are fairly well restricted to the specific types of science in which the workers have learned to do dependable work. This is a negative way of suggesting that so far as is now known, attitudes may be developed within specific fields by making specific efforts toward them. The American Psychological Association says that an attitude is "a stabilized set or disposition," and also that through continued use this "set" or "disposition" becomes emotionalized. This statement as well as an important discussion of attitudes, not restricted to scientific attitudes, has been published as part of an unusually significant volume,[1] officially made public as part of meetings now in progress in St. Louis. The representative and scholarly nature of the twelve men who prepared this volume and the three years devoted to the studies presented, enhance the significance of what appears in the volume. Five quotations from the section on attitudes and ideals are given.

". . . Nor can educators neglect to plan definitely for the development in secondary schools of desirable attitudes and ideals because they cannot adequately measure the results of their work. That is the fault of measurement." . . . (p. 292).

"The greatest difficulty is the present uncertainty of educators as to what the most desirable attitudes and ideals are." . . . (p. 292).

"The first and by far the most important step that educators can take is to recognize in theory and in practice that secondary education must plan as definitely for the development of desirable attitudes and ideals as for instruction in organized knowledge" . . . (p. 293).

"Again if the importance of attitudes and ideals is recognized it is clearly illogical to rely on their development merely through the process of instructing students in organized knowledge" . . . (p. 300).

"Promising endeavors of many kinds are being made to evaluate attitudes as they express themselves in typical individual behavior" . . . (p. 299).

[1] Committee on the Orientation of Secondary Education. "Issues of Secondary Education." *Bulletin of the Department of Secondary-School Principals* 20: 1–364; January, 1936.

Those seemingly well-founded statements, dealing with secondary education as a whole, are of large concern to those interested in elementary and secondary school science. Science has already made good progress, though not final, in defining its objectives including some of its desirable attitudes. By citing the oft-stated objectives of science teaching, it is shown that we have long believed in the development of desirable attitudes, even though we may have our doubts about securing them. Two summaries of objectives, one made by Hunter and Knapp,[2] the other by Davis[3] and a group of graduate students, probably represent our most comprehensive synthesis of science objectives. In these two lists, more than one-third of the stated objectives bear upon the question of attitudes. These are stated under such terms as the following: To develop the habit of scientific thinking; Develop scientific attitudes of approach in both old problems and in new situations; Develop habits of inquiry, and of interest in continued learning. Dr. John Dewey recently said that science in the curriculum should devote more time "to seeing to it that the sciences which are taught are themselves more concerned about creating a certain mental attitude." It is now those certain or definite and specific attitudes to which our research needs to be directed.

The psychologists for a long time have told us that an individual's predisposition, his habits of action, his attitudes toward situations have large effect upon his actions when in new situations in which those qualities may operate. That is, the specific ways in which *we have learned to respond,* are the ways in which *we usually do respond.* We commonly believe now that these learned ways of responding are not largely functional except in situations something like those in which the learning occurred. It would be unnecessary to repeat that statement were it not that so many scientists and teachers of science continue to claim that desirable attitudes may be had as the unconscious concomitants of factual study in science; that direct teaching effort is not needed in development of desired attitudes; that one should attend to learning his science with the expectation that doing so will cause him to become generally scientific in his reactions. These claims have never been proved, and what we now know about specific learning cuts away much of the basis on which the claims have been made. Organized knowledge is used both for its own mastery and for development of attitudes, but mere mastery has not been proved to confer attitudes.

The *Thirty-first Yearbook* of the National Society for the Study of Education recognizes the problem of teaching scientific attitudes. On page 27 it is stated that: "This analysis of educational values . . . illustrates some of the methods that have been the basis of attitudes that are functioning in human behavior." And later, same page, "The attitudes of science are those of respect for truth and the methods by which it is revealed." And again, on the same and the following pages, reference is made to "those values which are secured concomitantly from the study of natural sciences through forming generalizations respecting methods and through forming generalizations from which scientific attitudes may reasonably be expected to develop." Then under the heading of "Concomitant and Indirect Values in the Study of Science" (pp. 38 and 39) it is stated that "Attention is now directed to those values which arise indirectly from the study of science." . . . "Attitudes are also necessarily concomitant with the understanding of ideas and the understanding of methods. In their origins, attitudes are based upon understanding (or lack of it), and they are the reaction of a personality to learning ex-

[2] Hunter, George W., and Knapp, R. "Science Objectives at the Junior- and Senior-High-School Level." *Science Education* 16: 407–416.

[3] Davis, Ira C. "A Wisconsin Philosophy of Science Teaching." *The Wisconsin Journal of Education,* November, 1932.

periences. Desirable attitudes, that is, attitudes that are consistent with truth, are the ones that are formed as a result of satisfactory learning experiences." . . . "Scientific attitudes result from the impingement of implications respecting the generalizations and methods of science on the personality of an individual. Neither the method nor the attitude can exist *in vacuo*." Then from Chapter XV, pages 267–268, regarding "producing desirable scientific attitudes" we find the following statement: "Until these problems are attacked by the techniques of modern experimental education, such objectives as the development of training in scientific methods and the building of scientific attitudes will continue to be will-o'-the-wisp catch words to enchant unscientific science teachers."

The *Yearbook* contains other statements regarding desirable attitudes, but the quotations are believed to be fairly representative. That the statements are not harmonious is evident, though the elaborate and involved terminology sometimes used, makes it difficult to be entirely certain of their exact meanings. In the preface of this volume (page xii) we are told that the preliminary drafts of chapters "formed the basis of extended discussion by the entire Committee, during which the Committee found itself in complete agreement upon all the major issues and during which differences of opinion with respect to details were adjusted, or statements that after debate any member was unwilling to support were deleted." . . . And further it is stated that, "each chapter represents the unanimous views of the entire Committee." It is significant that each member of the Society's Committee is now author or coauthor of textbooks which now advocate definite instruction regarding attitudes. May we not properly assume that the entire Committee now believes in instruction regarding attitudes, not merely concomitant and subordinate development of attitudes. If this assumption is correct, should not this Committee, in the interest of fair dealing with the country's science teachers and administrators, publicly disclaim the inconsistencies in their published volume with clearness, with evidence for their present thought, and with the same vigor and wide distribution which was given to the original volume?

Do we not know less about the development of desirable attitudes than is sometimes claimed, on the one hand by those who say that attitudes are somewhat intangible by-products developed concomitantly by the study of science facts and processes, or, on the other hand by those who say that as a part of science teaching, specific attention must be directed to the desired attitudes? I know of no one who claims that desirable attitudes may be developed *"in vacuo,"* that is, developed separately from the study of science itself. The attempt that is occasionally made to confuse the matter by asserting that some would teach scientific attitudes apart from real science teaching needs no attention in this discussion, since probably no one believes in or undertakes such a venture.

The whole problem is much more complex than most students seem to have sensed. It cannot be reduced to reason by mere use of opinions nor by a few experiments. However, there are good guides for further investigations. Good working lists of some of the desirable attitudes have been set up and examined experimentally. The experiments, thus far reported, give a measure of evidence that specific attention to attitudes, along with other specific elements of instruction, does produce some desirable changes. These changes are, so far as yet proved, chiefly related to warranted inferences and conclusions, and to the student's stated change of his own attitudes. Whether these stated changes really operate in life situations is not yet adequately proved. Davis's work on measuring attitudes gives promise. Other researches known to this group but mentioned as illus-

tration, have been done by Curtis, Bedell, Downing, Watkins, Noll, Lundeen, and myself. Notably each of these contributions has dealt with a very small part of the whole problem. That is the way with science. What evidence there is stands on the side of incorporating in our science teaching adequate situations through which attitudes, as well as all the other worthy outcomes, may be treated; also, it appears that specific checking is desirable on these as well as other aspects of science. No end of investigations are needed before anyone may generalize regarding the whole question of scientific attitudes. Surely we do not know enough as yet to justify dogmatic assertions beyond the specific questions dealt with in careful studies already reported. Indeed, when enough careful investigations have been made we might have evidence enough to remove the attitude of dogmatism.

CHANGING CONCEPTIONS OF TEACHING HELPS IN GENERAL SCIENCE TEXTBOOKS*

MAITLAND P. SIMMONS
Irvington High School, Irvington, N. J.

PROBLEM

During the twenty-four years covered in this study, general science textbooks have undergone many changes relating to teaching helps. The purpose of the article, then, will be to ascertain by examination of general science textbooks published from 1911 to 1934: (1) What teaching helps show variation as to occurrence; (2) What teaching helps have remained constant as to occurrence; and (3) During what period have the greatest number of changes been introduced. Since general science is a required subject in many schools, this analysis should prove interesting to the general science teacher.

TECHNIQUE OF STUDY

Some more or less arbitrary criteria of selection had to be set up to reduce the number of contributing sources of data sufficiently to make the investigation practicable.

Therefore, the selection was based primarily upon the availability and wide use of the eighteen general-science textbooks listed.

For ease of interpretation the twenty-four years included in this analysis have been divided into four periods as indicated. General science textbooks of four publishers were used for each period. It is interesting to note that in the last period (1929–34) one publisher brought out a three-book series which, for convenience, will be regarded as a unit. Therefore, from now on reference will be made to sixteen general science textbooks, or four for each period.

From a careful examination of these books the teaching helps found in them for all periods were arranged alphabetically in Table I for the purpose of revealing different types of aids for a period, as well as indicating the total frequency of occurrence for all periods.

SUMMARY AND CONCLUSION

From Table I it seems reasonable to assume that aids for teachers adds to the value of general science textbooks. There are in the sixteen textbooks examined sixteen different factors which are of special help in general science teaching. These are (1) Demonstrations, (2) Exercises, (3) Experiments, (4) Footnotes, (5) Glossaries, (6) Key Statements, (7) Key

* Master's thesis (unpublished) *Changing Conceptions in General Science Textbooks* (1911–1934). State Teachers' College, Upper Montclair, N. J., 1935. Only such portions of the above study which pertain to teaching helps are here summarized.

Words, (8) Pictures, (9) Projects, (10) Questions, (11) References, (12) Reports, (13) Summaries, (14) Tables, (15) Tests, and (16) Topic Surveys. The findings of this investigation may be summarized as follows:

1. An examination of the table shows that the essential importance of these teaching helps. "Experiments" were not included in two books. A further investigation of the matter indicates that these books were the work of one author and that the second was a revision of the first. No reason is apparent to explain the omission of "Experiments" from these two books. These data seem to emphasize that general science is not entirely a textbook subject.

Textbook	*Author*	*Publisher*	*Copyright Date*
Period 1911–16			
1. *First Year Science*	Snyder	Allyn and Bacon	1914
2. *General Science*	Clark	American Book Company	1912
3. *General Science*	Elhuff	D. C. Heath and Company	1916
4. *Introduction to General Science*	Rowell	The Macmillan Company	1911
Period 1917–23			
1. *General Science*	Bedford	Allyn and Bacon	1921
2. *Civic Science in Home and Community*	Hunter and Whitman	American Book Company	1923
3. *The Science of Common Things*	Tower and Lunt	D. C. Heath and Company	1922
4. *An Introduction to the Study of Science*	Smith and Jewett	The Macmillan Company	1918
Period 1924–28			
1. *General Science*	Snyder	Allyn and Bacon	1925
2. *New Introduction to Science*	Clark	American Book Company	1928
3. *General Science*	Elhuff	D. C. Heath and Company	1925
4. *Science of Home and Community*	Trafton	The Macmillan Company	1926
Period 1929–34			
1. *Our Environment: Its Relation to Us (Book I)*	Carpenter and Wood	Allyn and Bacon	1933
Our Environment: How We Adapt Ourselves To It (Book II)	Carpenter and Wood	Allyn and Bacon	1934
Our Environment: How We Use and Control It (Book III)	Wood and Carpenter	Allyn and Bacon	1934
2. *Problems in General Science*	Hunter and Whitman	American Book Company	1934
3. *The World About Us*	Pulvermacher and Vosburgh	D. C. Heath and Company	1930
4. *General Science for Today*	Watkins and Bedell	The Macmillan Company	1932

"Demonstrations" appear only in the books of the last period. This may mean that "Demonstrations" are probably in the experimental stage.

2. "Exercises" occur in all periods with a few exceptions, thereby indicating the usefulness of this aid.
3. The high frequency for "Experiments" indicates that there is definite agreement as to
4. "Footnotes" receive very little attention. The reason for this probably is that the textbook content is adequate without further explanation.
5. Because of the lack of sequence in the appearance of "Glossaries" it seems unsafe to attach significance to their desirability.
6. Both "Key Statements" and "Key Words" occur in the latter periods which probably

indicates that they are a new form of teaching help.

7. Table I indicates that "Pictures" are used quite generally by writers of general science textbooks. They occur in all the books except *Introduction to General Science* by Rowell, published by The Macmillan Company in 1911. The writer's interest in pictures suggested a further investigation of the textbooks. It appeared that for the entire period 1911–34 there was a gradual increase in the number of pictures, there was greater variation in the kinds of pictures included, there was a general improvement in clearness, and there was greater coördination with subject matter.
8. A wide range is shown for "Projects" with a greater emphasis in the later periods.
9. The data show that "Questions" have been accepted as an essential factor in teaching general science.
10. "References" come into prominence in the later periods. This should tend to encourage and stimulate worthwhile individual general science reading.
11. There is little evidence to show why "Reports" should receive a place among the teaching helps.
12. "Summaries" are generally accepted as valuable aids in the learning process.
13. "Tables" show an increase in the later periods.
14. "Tests" and "Topic Surveys" are new additions. Textbook writers have not yet evaluated "Tests" and "Topic Surveys" as of enough importance to make their general use desirable.

TABLE I

TEACHING HELPS OCCURRING IN GENERAL SCIENCE TEXTBOOKS

Teaching Helps	Allyn and Bacon				American Book Co.				D. C. Heath and Co.				The Macmillan Co.				Total Frequency 1911–1934
	1911–1916	1917–1923	1924–1928	1929–1934	1911–1916	1917–1923	1924–1928	1929–1934	1911–1916	1917–1923	1924–1928	1929–1934	1911–1916	1917–1923	1924–1928	1929–1934	
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*	*P*	*Q*	*U*
1 Demonstrations ...			×					×				×			×		4
2 Exercises				×		×	×	×	×	×	×	×		×	×	×	11
3 Experiments	×	×	×	×		×		×	×	×	×	×	×	×	×	×	14
4 Footnotes								×		×							2
5 Glossaries								×	×		×						3
6 Key Statements ..				×													1
7 Key Words				×												×	2
8 Pictures	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	15
9 Projects		×	×	×		×		×							×	×	7
10 Questions	×		×	×				×	×		×			×	×	×	9
11 References		×		×		×	×	×					×		×	×	8
12 Reports		×					×	×								×	4
13 Summaries	×		×	×				×				×		×	×	×	8
14 Tables				×	×	×		×		×	×	×		×	×		9
15 Tests								×									1
16 Topic Surveys				×													1

This table should be read as follows: Demonstrations were included as a teaching help in the Allyn & Bacon textbooks published between 1924–1928 and in the American Book Company textbooks published 1929–1934, etc.

Column U, total frequency, 1911–1934, represents the sum total of each teaching help for all periods.

A glance at the table for the different periods would seem to indicate: (1) that marked variations as to occurrence were common among "Footnotes," "Glossaries," "Questions," "References," "Reports," "Summaries," and "Tables"; (2) that consistency of occurrence appeared for "Dem-

onstrations," "Exercises," "Experiments," "Pictures," and "Projects"; and (3) that the last period introduced the largest number of teaching aids. Such new additions were "Key Statements," "Key Words," "Tests," and "Topic Surveys."

GENERAL RECOMMENDATIONS

The investigator favors the use of all these teaching aids with special emphasis placed on pictures and experiments. All these helps afford the teacher an opportunity to vary his method with consequent greater interest. It is believed that these devices are of value in all books for the use of the teacher in making the learning process easier for the pupil. Moreover, they help to take care of individual differences. The fact that the books of the later periods contain a larger number of aids would seem to indicate that the authors of general science textbooks are trying to help the teachers. On the basis of the findings specific recommendations are as follows:

1. In the light of the importance of pictures as shown in Table I, it is suggested that all illustrations in general science textbooks meet the following criteria; (1) Contrast in black and white or color, (2) Clearness, focusing of attention upon parts which the author desires to stress, (3) Aptness, (4) Variety—photographs, cartoons, pen and ink drawings, diagrams, (5) Action—pupils performing experiments and demonstrations, (6) Scientific accuracy, (7) Up-to-dateness, (8) Color, and (9) Size.

2. There seems to be a consensus of opinion that experiments are of great value because of their place in the "learn by doing" method of teaching. It is recommended that teachers give emphasis to the experimental phases of general science in order to make the best possible use of the textbook material.

3. It might be mentioned here that the omission of "Projects" in the later books should not discourage their introduction by teachers. Because of the extended leisure hours of many pupils at the present time and since projects often lead to "Hobbies" and new scientific discoveries, the prevailing idea commends the use of more projects.

4. A recommendation favoring the use of more demonstrations is suggested here. Since the cost of equipment for demonstrations is much less than for individual experimentation, and since the results of recent studies seem to indicate that the demonstration work may be fully as valuable as individual laboratory work under some conditions, it would seem wise considering both utility and cost, to recommend as emphasis upon demonstrations. To a marked degree in the junior high school, teacher or pupil demonstration has replaced individual experimentation.[1]

5. In contrast to the almost unanimous agreement regarding the importance of pictures and experiments, observation shows a diversity of opinion as to glossaries and footnotes. Books containing these teaching aids are in the minority. The reason may be that modern general science teaching requires fewer technical terms. It is recommended that teachers give special attention to supplementary textbook material where glossaries and footnotes are lacking.

BIOLOGY ENROLLMENT AND CURRICULUM PLACEMENT IN CALIFORNIA SECONDARY SCHOOLS*

Helen D. Orsborn
High School, South Pasadena, California

The increasing importance of biology in the secondary science curriculum is of interest to both science administrators and teachers. In the course of a broad investigation into the status of biology in the secondary schools of California, a number of significant facts concerning enrollment and placement of the subject were discovered.

Four possibilities are open in the placement of biology in California secondary schools, largely due to existing college entrance requirements. It may be studied in the ninth or tenth year as a required or elective subject, in which case it shall not

* Abstract from *The Status of Biology in California Secondary Schools.* Master's Thesis, University of Southern California, 1933.

[1] Beauchamp, Wilbur L. *Instruction in Science.* National Survey of Secondary Education. Monograph No. 22. U. S. Office of Education. Bulletin, 1932, No. 17. Washington, D. C.: Government Printing Office, 1933. p. 63.

be offered as a laboratory science for college entrance, but may be used as a science for high school graduation at the discretion of the individual school. The term "laboratory science" denotes a subject having at least three forty-minute recitations per week and two double laboratory periods, or their equivalent. Biology may be placed in the eleventh or twelfth year as a laboratory science for high school graduation and college entrance or for high school graduation only. Many of the colleges in California prefer chemistry or physics as a laboratory science in satisfaction of their requirements, although biology is accepted. With this last fact in mind, the large enrollment in biology is especially significant. It would seem to be fulfilling a universal need.

BIOLOGY ENROLLMENT

The first source of information concerning the prevalence of the subject in the secondary curriculum was the California School Directory for 1930–1931.[1] Three hundred seventy-nine schools were included, of which two hundred ninety-five, or 77.83%, named an instructor or instructors in biology. An investigation made in 1924[2] gave 1.7% of California high schools offering biology, in 1907–8, 48%, in 1919, and 59.9% in 1923. The percentage of 77.83% in 1931 indicates a continued gain for the subject.

The second source of information concerning the placement and enrollment in California secondary schools was found in the returns from questionnaires sent to some four-hundred biology teachers in the state, one hundred fifty-eight of whom replied, representing 130 schools. One hundred fourteen of these replies gave full information concerning enrollment. These schools were grouped for laboratory purposes into junior, four-year and senior high schools. Information was asked concerning the general enrollment and enrollment in each of the sciences, also placement of biology in the curriculum.

The percentages of students enrolled in biology ranged from an average of 15.85% in four-year high schools and 16.8% in senior high schools to 20.94% in four year junior high schools in a city in which biology is a required subject. In general, a higher percentage enrollment in biology was found in the smaller schools. This may be due to two factors; the ease with which the smaller schools can equip and carry on biology as a laboratory science in comparison to physics or chemistry, and the wider range of offerings to be found in the larger schools which lowers the percentage enrollment in any one subject.

The enrollment in biology far exceeds that of any other natural science. Botany and zoology are negligible while physiology has approximately one-eighth of the enrollment found in biology. The following tables summarize the enrollments in the natural sciences in 130 four-year and senior high schools, and the physical science and biology in 114 four-year and senior high schools:

TABLE I

ENROLLMENT IN NATURAL SCIENCES

Subject	*Schools offering*	*Enrollment in subject*
Zoology	4	223
Botany	11	424
Physiology ...	18	2487
Biology	128	16509
Totals	130	19643

[1] *California School Directory, 1930–31.* California Society of Secondary Education, November, 1930.

[2] Bailey, Edna W., Foster, Lawrence F., Ewine, Florence G. "Science in California Schools." *University High School Journal* 14: 47–67; March, 1924.

TABLE II
ENROLLMENT IN PHYSICAL SCIENCES AND BIOLOGY

Subject	*Schools offering*	*Enrollment in subject*
Physics	100	4060
General Science .	17	5731
Chemistry	108	7935
Biology	113	12120
Totals	114	75648

PLACEMENT OF BIOLOGY IN THE CURRICULUM

One hundred twenty-two schools gave complete information concerning the placement of biology. The most popular use of the subject seemed to be as a tenth year elective (46 schools), and in the eleventh and twelfth years for high school graduation but not for college entrance. Thirty-two schools used biology as a tenth year elective and as a laboratory science for high school graduation and college entrance. Ten schools listed biology in the eleventh and twelfth years only, for both high school graduation and college entrance.

In seven schools it was a required tenth year subject. No contrasting tendencies were noticeable in schools of large and small enrollments. An overwhelming majority placed biology as at least an elective in the tenth year.

In an investigation carried on in 1924, Hunter[3] found that 16.09% of schools replying placed biology in the ninth year, 48.13% in the tenth, 3.47% in the eleventh, and 2.67% in the twelfth year. It would appear that the tenth-year placement has become more marked and that the use of biology as an eleventh and twelfth year laboratory science has also increased.

There is surely a field for further study on the advisability of placing biology in the tenth year or its use as a laboratory science in the eleventh and twelfth years. No definite information as to the advantage of either plan seems available although general usage points to the tenth year as more advisable.

Biology seems deserving of a more definite place in the curriculum of the secondary school. Its use as an elective in the tenth year and a laboratory science in the eleventh and twelfth years leads to a duplication of effort and a confusion of objectives and methods in teaching. In smaller schools an anomalous situation exists whereby tenth year students are enrolled in the same classes as the eleventh and twelfth year students, carry on the same work, and yet may not count the credit as a "laboratory science."

Botany and zoology seem to have passed definitely into the college grade. This follows the trend of modern educational practice in placing the specialized subjects in the field of higher education. It would seem advisable to close those subjects out of the high school curriculum.

Teacher training for biology instruction in secondary schools should cover a broad field as the subject becomes more general and basic. A high degree of specialization in the individual biological sciences is no longer necessary, or, in the opinion of many, advisable for a biology teacher.

Biology must be acknowledged as the leading subject in the science field, and administrators and instructors alike should be alert and active in following its further development.

[3] Hunter, George. "Is There a Sequence in Secondary School Science?" *School and Society* 20: 762-766; December 13, 1924.

A STUDENT INVESTIGATION OF TRAP-DOOR SPIDERS*

HOLLIS P. ALLEN

Claremont Colleges, Claremont, California

TRAP-DOOR SPIDERS[1]

Up where the mesa lies brown and dark
Under the heat of the summer sky,
This toiler lived; and with cunning art
Carved out a home from the mesa's heart.

He lined the walls—a beautiful sight—
With his silken web—all finished in white.
He shut it in with a wonderful door
Finely fitted to mesa floor.

Then the silken hinges with great care
He patiently wove; till beauteous, fair,
The home of the spider stood complete
Upon the mesa at mountain's feet.

And men walked carelessly by and o'er
The wonderful house and its beautiful door;
But the eyes are holden: they see it not,
The architect's work in that favored spot.

The trap-door spider, although one of the least known to the common public, is one of the most interesting animals that can be studied. With its unusual habits and its cunning ways of protection, it makes such an interesting study that I often find myself "trap-door spidering" when I ought to be studying algebra or Latin.

* Editor's Note: There is nothing new under the sun. Nomenclature changes, but methods do not change. In 1914 the following student investigation was made. It was then doubtless called "extra credit work." Today this same investigation would be called "a project." The originality and freshness of this investigation with its extremely interesting experimental data has made it seem worth while to publish it. The writer of this article is now a professor of education in Claremont, California. He has been persuaded to allow the printing of this material in its original dress, so that the secondary-school student of today may see what a schoolboy accomplished as an outside activity twenty odd years ago. The drawings and photographs of the original paper are not included.—GEORGE W. HUNTER.

[1] The above is very true, being written by a curio man who collected Trap-door spiders for a living.

The full-grown spider measures a little over an inch in length of body, but when its legs are extended, it looks much larger. It has large mandibles extending out from under the chitonous shield over the dorsal side of the thorax. On the under sides of the mandibles are two claws, which it uses to hold down the door. On the foreward side of the shield are eight small eyes. It has four pairs of true legs, and one pair of palpae which look very much like legs. The abdomen is almost round, and narrows to a small projection which joins to the thorax. At the end of the abdomen are two spinneretts, from which issues the silk which it uses to line its hole with. On the ventral side of the abdomen are two light spots which are clearly seen on the background of brown. The trap-door spider is often confused with its close relation, the tarantula, but is different, in that the tarantula is larger and is heavily clothed with hair while the trap-door spider has only a few hairs on its legs, and "fuzz" on its abdomen.

The spider lives in the ground, and very rarely comes out. They build their holes in dirt which packs very hard and does not crumble, away from thick vegetation, and in foothill regions, and in valleys such as San Gabriel and Chino valleys. Although I have not noted any living out of these areas, they probably do.

The spider prefers to build its hole when the ground is damp, although forced to it, will build in hard ground. In the middle of March, when the ground was damp, I noted a hole which was in the process of construction. It had, as yet, no door and no lining. Another hole had the door on, but it was smooth, not being finished like the surrounding dirt. I had a small spider in a jar with packed dirt in it. The

spider would not dig for itself until I started a small hole, then it "got down to work." It brought the dirt up in small pellets, about ¼ of an inch in diameter, and dumped it in a depression on the opposite side of the jar. As the hole became more complete, the pellets of dirt became smaller. I think that this is because little pieces of dirt were taken off here and there to make the hole smooth. I think that it is one of the most wonderful things, the extremely smooth finish which they put on their holes. The holes usually are dug down almost straight for about two inches, then turn slightly to one side or the other, then coil in gentle curves to the bottom which is bulb-shaped, and slightly enlarged. Description of a trap-door spider hole: The hole was about ten inches deep. When digging this spider out, I followed down one side of the hole, injuring the lining as little as possible. In this way I got a perfect cross section of the hole. I then took the lining and door out in one continuous piece. The spider was sitting in the bottom of the hole, in under the pouch of eggs. It would not come out of the end of the hole, although I had dug clear to it, so I was forced to pull it out with my fingers. I did not want to do this, as they are said to be poison, but it did not strike, although it lifted up its palpae, and opened its mandibles. In two other cases I made lead casts of the holes. I poured alcohol down the holes first to kill the spiders, then poured in the melted lead. Both of the casts turned out good. One cast was made of a hole which I had broken into a few weeks before, and taken off the upper part of the hole. The spider had built a new door, and I supposed that it had deepened its hole, but it had not, so the cast is quite short. It was quite a small spider that lived in this hole. The other cast was made of a full-sized hole of a small spider. The lead was poured in, in two lots, so that it made it somewhat rough near the bottom (B). Both of these casts showed the form of the spider very plainly. I have found a number of small holes which were less than one quarter of an inch in diameter. These holes can only be found by taking off the surface of the ground and exposing the holes, as the doors are so small and perfect that they cannot be seen. I suppose that when the small spiders leave the mothers' hole that they go out and build their own, and enlarge it as they grow larger.

Besides the form of hole already described, I have seen a very peculiar hole of a spider who was shut up in a can. My father was digging, and found a spider, which he put in a tomato can with a piece of glass over it. This made it almost air-tight, but the spider lived, and we forgot all about it for over a year, when we opened it up, and found that the spider had dug two holes which connected at the bottom, and he had made two chambers, one below, and one above. I do not know why this hole was made this way. Maybe he was "hard-up" for something to do, being so shut up, so he spent his time digging. This is the only hole of this kind that I ever saw.

The cover of the hole is his way of protection. It is made of small pieces of dirt, fastened together by web, and looks very much like the surrounding dirt. The under side of the door is covered with three layers of very tough web. There are two holes where the spider sticks his claws in. When anything approaches, the spider always has the door held down. It takes quite a bit of strength to break the grip of the spider hanging onto the cover. But as soon as he lets go, he goes down his hole so fast that you never get a chance to see him, try as hard as you may to open the door quickly. On the door of one spider's "house," a dark design was worked into the white silk of the top layer of the door. It appears very much like a flag or ensign on the door to show what nationality the spider is. The pattern is not constant, but I have seen a part of a design on other doors. I do not know the

reason. Whenever I begin bothering a hole, the spider puts a projection of silk up around the inside of the hole. This may be removed, as it was in one hole. I think that this is put on, so that the spider may have more space to brace his feet in holding down the door.

The egg sack was found in the bottom of the hole of the spider. It was very white, looking and feeling as though it was made of white tissue paper. It was suspended from the top of the bulb-shaped end of the hole by three or four threads, and was easily taken off. There was just enough room in under it for the spider to sit. The pouch was filled full of the eggs which were not fastened together, but were loose. The eggs later shrivelled up.

I have noted several interesting things about the spiders which I will tell. In one case, I opened the door of a nest, and I must have injured it somewhat, for the next day, the old door was about six inches away, and the hole had a new door. Down one large hole I placed a stick about six inches long and one quarter of an inch in diameter. I was going to see if the spider could remove it, and if not I would take it out myself. The next morning I went out, and the stick was out, having been cast quite a distance away.

When I put the large spider in my jar, there was a small spider which had a hole in the same jar. The large one walked around the jar several times, going right over to the hole and immediately the large spider tried to get in. It was almost comical to see it try to squeeze in, but after trying about five minutes it backed off. That night it tore off the door of the small hole, and began digging it large enough for itself. The dirt was very hard, so progress was slow. It only made about three inches in as many days. As I wanted to draw this spider, I had to take him out. This I did by filling the jar full of water until the dirt was soft, then digging him out. At the same time I dug the small one out too. And putting the two together, I thought I might get a fight, but they ignored each other. I then caught a large black poison spider, and put it in with them. They did nothing, so I went away, and in an hour came back to find both of my spiders wrapped in a web, and suspended in mid-air. I was mad, so I killed the poison spider, and unwound the web from the trap-door spiders. They both seemed to be dead, but the next morning the smaller one seemed to have a little life in him. The other was dead, so I took the two to a large trap-door hole and opened it up. I placed the small one in the mouth of the hole, then I shut the door and immediately tried to open it again, but the spider was holding down very hard. I finally forced it, and the little spider had disappeared. Then I placed the dead spider in the hole, but the spider did nothing. I grew tired of waiting, and came back about ten minutes later to find the dead spider carried away about ten inches from the hole. I suppose that my "colony" of trap-door spiders would be very glad to hear that I have finished my paper, as I have been pretty hard on them, but now I will give them a rest.

Editorials and educational news

A PHILOSOPHY FOR TEACHING SCIENCE IN A CHANGING WORLD

Forty years ago this fall, the writer began his apprentice teaching as an assistant in the biological laboratory in a New England college. Today he looks upon a different world from that of his boyhood. Different in methods of lighting, heating, sanitation, and building construction; different in methods of transportation and communication; completely changed in its knowledges concerning diatetics and nutrition, the uses of vitamins and hormones, the causal agents of disease and our methods of fighting them. And these contrasts have been brought about through the applications of science in human affairs.

To keep pace with these changes and successfully to make them meaningful to our pupils, our philosophy of science teaching must be pragmatic. We are not so much concerned with theories or even the "big ideas" of science as we are in their practical applications in the lives of those we teach. As one of the editors of this Journal has recently said, "The human organism is in constant interaction with his environment, both as an individual and as a member of the social group." If he is to make the necessary adjustments for sane and healthy living, he must integrate his science experiences with those of his workaday world so that he may intelligently interpret such experiences and solve the problems that he meets in the environment in which he is placed.

The solving of problems has been man's lot ever since he first appeared on the earth. He has muddled along through unnumbered centuries and today, in spite of the changed world in which he lives, he still commonly ignores the fundamentals of the scientist's methods of attacking such problems. It would therefore seem that one of the chief values of science in the modern curriculum would be an exposure of young people to the method of science. The beginner in science ought constantly to be habituated in the use of the inductive and deductive methods in problem solving. The problems presented need not be difficult, technical, or abstract. On the contrary, they should be concrete and related to the life experiences of the learner. But they should be used on every possible occasion so as to habituate the student in a way of looking at his life problems. Motivation of the truest kind comes through the discovery of problems that the child adopts as his own. The richest implications of Gestalt psychology lie in this problematic approach, for the child needs to see where he is going in order to arrive at the goal. The wise teacher will use such techniques as will best aid in attaining this end. The Morrisonian idea of the preview in unitary development is sound psychology because it presents the goal at the most opportune time. The recent trend toward the early presentation of "big ideas" and generalization is also sound because it uses the same psychological ap-

proach. But here the weakness lies in the fact that young children, because of their immaturity, may memorize generalizations that are meaningless to them. If education is to be a continuous process, then generalizations must grow out of experiences. Again our pragmatic philosophy demands that we adopt such of these educational practices as we find by experiment will work, remembering constantly that we are dealing with individual differences and not with classroom groups.

As a corollary of what has just been said, it is evident that if science teaching is to bear fruit in the attitudes, activities, and knowledges of most worth to the learner, then such activities and knowledges must be integrated in the curriculum so that society as well as the individual may gain through such experiences. To become a thinking citizen, one needs the attitudes and knowledges that science can best give when integrated with civics and history. Consumer needs can best be met through science integration with commercial subjects, home economics, and the social studies. The health goal certainly cannot be attained without integration with biological science. The old-time formalized subject matter is disappearing (as can be seen in restrospect of forty years of active teaching) and in its place a socialized curriculum is arising. In this curriculum, science will play a most important part, because it will best help the learner to live healthfully and successfully in his environment.

Finally, my philosophy of teaching has always been Herbartian. Children have definite interests, just as do adults. The testimony of adults may not always be reliable, but it is admitted as evidence in court trials. The testimony of children may not always be reliable, and their interests naturally are effervescent, but by building on the child's natural interests, we may lead him to the acceptance of truths which are fundamental. There is so much of interest in the world of science that our science classrooms ought to be filled with youngsters who work for the joy of working, and instead of decreasing enrollment, science should be accepted as one of the most important of the core subjects in an integrated curriculum. When this day comes, we need not fear for the future of science teaching in this country.

GEORGE W. HUNTER,
Claremont Colleges,
Claremont, California

INTERPRETATIVE GENERALIZATIONS AS AIDS IN CURRICULUM WORK IN SCIENCE

There are striking contrasts between educational theory of a generation ago and of today. The older theory stressed the development of the powers of the individual. Emphasis in teaching was on physical, intellectual, and moral training. This emphasis was supported by conceptions of mental discipline and by the demands for preparation for the responsibilities of adulthood and for further education. Educational theory of today is influenced by consideration of social needs. It is in effect an expression of a social philosophy. Emphasis in teaching is on understandings which will guide action, on the social consequences of action, and on ideals and attitudes, ways of thinking, and conceptions of value which will aid in the evaluation of consequences. The effects of this newer theory may be seen in recent reports on science teaching.

The report of the Science Committee of the National Society for the Study of Education (the *Thirty-first Yearbook*) is one of the pioneer efforts to adopt science teaching to a social philosophy of education. This Committee recognized the influence of scientific achievements on our society and on the activities that go on in it. The report is an effort to give guidance in educational planning which will result in a greater use of intelligence in these activities. The

Committee accepted life enrichment as the aim of education and defined enrichment as that which enables the individual to participate intelligently and with satisfaction in the experiences of living in a democratic society. The report outlines a plan for a program for teaching science, continuous through the elementary and secondary school and articulated with the college, designed to relate achievements in understandings in science to the influences, actual and potential, of these achievements on individual and social life.

A significant feature in this report is the recommendation favoring the use of broad generalizations as agencies for relating understandings of scientific achievements to human experiences. These generalizations, which in contrast with pure science generalizations may be called interpretative, are used as guides in the organization of subject matter. The importance of this feature in the recommendations is that it suggests a definable procedure for accomplishing a closer integration of school activities and social activities. It is important to note that other educators, working contemporaneously with this science committee, particularly in the social studies and more recently in mathematics and some other fields, have favored a similar use of interpretative generalizations in the organization of subject matter.

This recommendation has had wide acceptance among curriculum workers in science. These interpretative generalizations are serving at least three related functions. Probably the most obvious function is that they associate ideas from different areas of specialization thus bringing together, in meaningful relations, ideas from more or less discrete subjects. The second function is that they relate the content of instruction to life. This second function is really a consequence of the first. When ideas from different subjects are brought together in meaningful relations the associations of ideas are necessarily more nearly in agreement with the associations that are made in thinking about life activities than associations which are limited by boundaries of subjects. The ideas associated in interpretative generalizations tend to be, in fact, the ideas that are associated in thinking about life activities. Such generalizations must in the nature of things "ramify into human affairs." The third function is that they serve to guide in planning for continuity in science teaching at the same time they serve to guide in correlating science with other areas of instruction. Illustrations of their use in curriculum making may be seen in courses of study of recent issue for elementary and secondary schools and for colleges.

It must be clear that this procedure in curriculum making is of no significance for itself. It is a means to an end. In this instance it is a means for using understandings that have come from scientific achievement in accomplishing the educational aims suggested by a social philosophy. The use of interpretative generalizations for this purpose requires that the curriculum maker see the relationships between subject matter from different fields and it requires that he see the relationships of his subject matter to human activities. With recognition of relations to human activities he is able to select, from the broad areas, content which will contribute to greater use of intelligence in these activities. Interpretative generalizations are useful to curriculum workers and to teachers for directing the course of effort in a continuous program of socially significant science teaching. Obviously, they are not statements set down to be learned or mastered by students. In fact, mastery of an interpretative generalization seems unthinkable.

A recommendation is useful if it stimulates teachers and others to study critically and to evaluate their own work, and if it furnishes guidance in relating their work more closely to acceptable educational aims and functions. By these criteria the recom-

mendation favoring the use of interpretative generalizations in curriculum work in science has served useful purposes.

SAMUEL RALPH POWERS,
Teachers College,
Columbia University

A PATTERN FOR SCIENCE TEACHING

With the ever-expanding scientific knowledge, the science teacher may well ask: "What is of importance to the young student? What is it we want the pupils to derive from their study of elementary science, general science, biology, physics, or chemistry?" Facts innumerable may be listed, no one of which seems really essential. On the other hand, there are certain principles or certain ideas—concepts (call them generalizations if you will), which, if possessed by the student, should enable him to understand and appreciate better those daily happenings he encounters from the time he awakens in the morning until he closes his eyes in sleep at night. *What shall we teach?*

To be sure, science teaching is one of the tools used for "processing" pupils to fit them to take their places as useful members of society, and to enable them to get for themselves a maximum enjoyment out of living. Thus may science teaching contribute both to the work-time and leisure-time needs of the child. If science teaching is to be an effective tool for this "processing," teachers must use methods that will conform to, or aid the learning processes of the pupil. Science teaching must not be solely a "pouring in" and "ramming down of measured doses of information." It must provide for the development in the pupil of those attitudes and abilities which society has found useful in meeting and solving life's problems. *How shall we teach?*

A twelve-year program of science education must provide for the development of skill in the use of the method of science by actual practice in using it throughout the whole elementary and secondary school period, if returns to the child are to compensate him fully for his time and energy. Only as science training developed through these years actually fits the child to apply his knowledge of science scientifically, so as to understand and appreciate nature and himself, and to serve as a useful citizen because of his abilities and his attitudes, can science expect to hold its place as a necessary part in the general education of the child. *What results do we expect from our teaching?*

The above questions are answered by implication in the three paragraphs above, and indicate to that extent my philosophy of science teaching. The methods or "processing" patterns that have been in use in the Rochester schools for nearly a decade involve instructional units based upon problem-solving by the pupil. An instructional unit provides not only for the acquisition of facts and for training in the scientific method of problem-solving, but for practice in using facts and principles secured to solve problems met in everyday life. Thus the method becomes a tool for better thinking and living.

Each instructional unit structurally contains three or four sets of problems contributing to the development of as many simple concepts. These concepts function as building stones, or stepping stones, by which the pupil is able, with guidance, to arrive at larger inclusive concepts or generalizations. This is the learning objective of the unit.

The general concept of each unit is selected as representing a desirable learning product in the content area. This, in turn, is analyzed into the contributing or minor concepts. Problems are the result of experiences with children.

No claim is made that the major concepts are most desirable, or that they have been most accurately analyzed into the minor or contributing ideas. Indeed, individual teachers using a given unit as a pattern are encouraged to make changes

as they may be required or suggested as the result of varying types of classes, special interests of children, *etcetera*. In this way, individual pupil needs are met. The important thing is that we have here a pattern which, if carried out in its essential features by pupils under the direction of the teacher, not only provides the pupil with an adequate supply of factual information, but also provides for directed practice in problem solving and in making generalizations.

The problems vary in character. Many involve individual and group laboratory exercises, both in the laboratory and outside of school. Some involve library reference work in addition to the usual textbook work. Others are purely observational in character, being intended to direct the pupil's attention to specific happenings in his daily life. Some problems involve all kinds of activities.

This "processing" pattern provides for a desirable pupil-teacher relationship, in that the teacher no longer feels the need to expound a principle or passage from the text. Rather is it possible for him to occupy the position of a real teacher, guide, and counselor to the pupil as the pupil proceeds with his business of problem solving, gaining practice in scientific thinking and doing, and deriving or developing valuable ideas as a result of his efforts. This pattern minimizes the tendency to indoctrination in science, and emphasizes pupil initiative, resoucefulness, and individuality.

Through science, pupils should be well read in science, skilled in the use of the methods of science and in scientific thinking. This training should profoundly affect their conduct and outlook on life.

HARRY A. CARPENTER,
Rochester, New York,
Public Schools

SCIENCE EDUCATION FROM THE STANDPOINT OF PSYCHOLOGY

There are at least two questions basic to a consideration of the outcomes of science instruction. (1) What is learning? From a careful examination of the *Thirty-first Yearkbook* of the National Society for the Study of Education, it would seem that Thorndike's mechanistic S–R bond theory is accepted as the basis of a psychology of science learning and teaching. Learning is seen as a "progressive and continuous process of forming connections between situations and responses." The psychological principles suggested as a guide to the science teacher are apparently also those of Dr. Thorndike. (2) what are the outcomes or objectives of science teaching? There has been a tendency among science educators to place the outcomes of science teaching in four catagories: (a) Specific habits and motor skills (b) knowledge, commonly referred to as facts, concepts, principles, laws and generalizations (c) understanding and use of the scientific method (d) general patterns of conduct such as ideals, interests, tastes, and attitudes, particularly scientific attitudes.

Certainly it is a fair assumption to say that there should be no conflict between the proposed or supposed outcomes of science teaching and the psychology of science teaching. According to the S–R bond theory of learning education becomes a series of changes in the individual which results in the building up of thousands and thousands of S–R bonds. The question is: Can this view be made to apply to all of the suggested outcomes of science teaching? It is debatable as to whether this question has been faced squarely by science educators. There seems to be a shifting between a mechanistic conception of learning and purposive learning which is a little bewildering. This criticism applies especially to the matter of problem solving and the development of scientific attitudes. Is this shifting necessary? Perhaps not. There is something almost irresistably fascinating to me in contemplation of the belief that problem solving and the development of scientific attitudes may be understood and best explained on the basis of the S–R

bond theory. Is not an attitude a definite habit or a group of habits? In connection with problem solving we must remember that; reasoning ability is specialized, that a person must know a great deal to solve problems, and that a person must build up a number of subtle habits for problem solving. After all cannot problem solving be reduced to a number of skills? And are not skills simply chains of habits? And are not habits simple S–R bonds?

If the above statements are true then what we need to do is to analyze the scientific method and scientific attitudes into definite habits and skills. The next step would be to determine through experiment the learning exercises necessary to develop these skills and habits. We can be sure that the laws of learning will apply here as elsewhere.

Many of us teach science with the hope that somehow scientific attitudes will result and that the habit of using the scientific method will become a part of the learner as concomitants with the learning of facts and principles. With this belief we are in a field of chaos. The acquisition of scientific attitudes as a by-product of performing laboratory experiments, observing demonstrations and reading textbooks rather than as the product of independent learning activity is by no means certain. It is crucial to a consideration of all science learning whether we view science education as growth and development of the individual through progressive socialization or whether we envisage science education as a multitude of specific learnings objectively determined and objectively measured.

ELWOOD D. HEISS,
State Teachers College,
East Stroudsburg, Penna.

TENTATIVE PROGRAM OF THE AMERICAN SCIENCE TEACHERS' ASSOCIATION

(Affiliated with the American Association for the Advancement of Science)

ATLANTIC CITY—DECEMBER 31, 1936

Morning

Composition of the Upper Atmosphere

Speaker: W. J. Humphreys, U. S. Weather Bureau

The Relative Claims of Natural Science and of Social Studies to a Core Place in the Secondary School Curriculum.

Speakers: For Natural Science—Dr. Oscar Riddle, Carnegie Institution of Washington
For Social Studies—Dr. Roy W. Hatch, Montclair State Teachers' College

Discussion by leaders and from the floor.

Luncheon

Speaker: Dr. Edwin G. Conklin, President of the American Association for the Advancement of Science
(*Please make reservations in advance.*)

Afternoon

The Next Ten Years in Science Education

Speaker: Dr. Otis W. Caldwell
Discussion by leaders and from the floor.

The Need for a National Publication for Science Teachers

Speaker: Professor Earl R. Glenn, Montclair State Teachers College

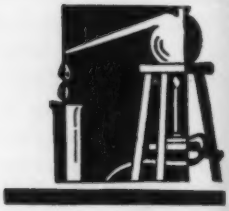
Discussion by leaders and from the floor.

Desirable Training for Science Teachers

Speaker: (To be selected)
Discussion by leaders and from the floor.

Business Meeting

Abstracts



SCIENCE

Symposium: "Unfamiliar Elements; Physics of the Future; Human Associations and Societies." *The Science Leaflet* 9: 1–29; May 7, 1936.

This final *Science Leaflet* was a most interesting one. Two of the most interesting articles were a radio address by Dr. Irving Langmuir in which he was interviewed by two high-school students on "What Are Atoms," and a second article on "Physics of the Future." —C.M.P.

Weymouth, Ethel. "Static Electricity." *The Science Leaflet* 9: 12–15; April 2, 1936.

This article contains some very interesting notes on the not-so-often discussed subject of static electricity. —C.M.P.

Greene, Robert A. "The Composition and Uses of the Fruit of the Giant Cactus (Carnegiea Gigantea) and Its Products." *Journal of Chemical Education* 13: 309–312; July, 1936.

The large cactus found in Arizona and northern Mexico yields a fruit which is a source of food for the Indians. The fruit contains about 6.6% sugar. From it are made a sirup, a preserve or jam, a wine, and vinegar. —V.H.N.

Barton, Thomas F. "The Great Plains Tree Shelterbelt Project." *The Journal of Geography* 35: 125–135; April, 1936.

This is an excellent discussion of the proposed tree belt for the Great Plains region. Diagrammatic sketches add to the usefulness of the article. The kinds of trees and shrubs that are to be planted in this belt are enumerated, the objectives that underlie the project as well as the chances for the success of the project are discussed. —C.M.P.

Cole, H. N. *The Skin in Health and Disease.* Part II. Hygeia 14: 332–334; April, 1936.

In this article, the author discusses the causes and characteristics of eruptions of the skin, such as impetigo which is due to streptroccocus and staphylococcus organisms; warts due to a filtrable virus; ringworm; scabies, formerly called "itch"; and pediculosis, commonly termed lice. Many of these skin diseases can be prevented through isolation of infected persons and careful inspection and supervision in schools, gymnasiums, shower baths, golf clubs, swimming pools, and barber shops. —F.G.B.

Cole, H. N. *The Skin in Health and Disease.* Part III. Hygeia 14: 448–450; May, 1936.

In the third and last article of this series, the author discusses the cause and general care that should be taken of syphilis; skin conditions commonly known as birthmarks; cancer of the skin; and sailor's skin. This is followed by a consideration of the general care that should be given the skin and its appendages, the hair and nails. He urges consultation with the family physician in regard to skin disturbances and emphasizes the dangers of treatments by quacks and by the man who advertises. —F.G.B.

Herschensohn, Herbert L. *The Germs We Live With. The Tubercle Bacilli.* Hygeia 14: 321–323; April, 1936.

There are evidences that the tubercle bacillus is as old as mankind although it was not until March 24, 1882, that its discovery was announced. Shortly after this date it was found to be the direct cause of consumption. Perhaps the earliest evidence of its existence of this bacillus was found in a skeleton of a person who lived at least 10,000 years ago. The hunchback condition gave mute evidence that tubercle bacilli had attacked the body. The author explains how such a deformity is brought about by the work of the organisms.

While tubercle bacilli are the direct cause of tuberculosis, ninety per cent of human beings harbor them somewhere in their bodies but only a small percentage show evidences of infection. The author discusses various factors that are essential to their successful attack on the body. —F.G.B.

Anonymous. "The Greatest Mystery of Science." *Popular Mechanics* 65: 166–167, 152A; February, 1936.

A brief discussion of the cosmic ray apparatus carried by Stevens and Anderson in the latest stratosphere ascension. —O. E. Underhill.

HOWERTH, I. W. "Races and Race Contact." *The Phi Delta Kappan* 18: 171–176; February, 1936.

This is a brief but interesting discussion of race types and the effect of race contacts on civilization at various times. In conclusion the author says, "We have seen that the ideas of race and races are much more indefinite than they are commonly supposed to be; that races are hard to distinguish; that they shade into each other; that there are no pure races; that there are three great racial groups of races, each containing many sub-races which, though akin, have deep-grounded prejudices against each other largely because they think they are unrelated." —O. E. Underhill.

LUTZ, FRANK E. "How About the Tent Caterpillar?" *Natural History* 37: 149–158; February, 1936.

This is an illustrated article by a well-known entomologist in which he emphasizes the "balance of nature" and the hesitancy man should use in interfering with this "balance." —C.M.P.

MAGEE, H. W. "Aluminum, The Wonder Metal." *Popular Mechanics* 65: 169–176, 128A–130A; February, 1936.

Less than a century ago aluminum was as costly as gold; in 1852 it cost $545.00 a pound. With Hall's process, costs were so lowered that it became a common metal. Before the electrolytic process was developed, Napoleon III wished to equip an army with this light-weight metal, but cost limited him to buttons on uniforms and souvenir tableware for honored guests. "Less honored guests were forced to eat with Napoleon's plain gold and silver tableware." Aluminum now ranks fifth in tonnage produced and used. Probably no other metal can be obtained in so many diversified forms. New methods of dyeing have increased further its range of usefulness. Many other interesting facts about the discovery of aluminum, methods of obtaining it, and its uses are given. —O. E. Underhill.

Anonymous. "Flying the Beams." *Popular Mechanics* 65: 402–404, 138A; March, 1936.

A brief but interesting presentation of how radio beams are used to guide fliers. —O. E. Underhill.

CROWLEY, C. A. "Designing and Building Thermostats." *Popular Mechanics* 65: 628–633; April, 1936.

This is an excellent article telling how to calculate the proper sizes for compound metal arms for thermostats of various types and for various purposes. Detailed construction of many forms is given. —O. E. Underhill.

JOHNSON, THOMAS M. "Britain's Giant Superliner." *Popular Science Monthly* 128: 16–18, 130. April, 1936.

This illustrated article describes the new British liner *Queen Mary* which is 1018 feet long and 234 feet tall, with a capacity for 3,500 passenger and crew. There is an excellent cross-sectional diagram. —C.M.P.

BOONE, ANDREW K. "Modern Gypsies." *Popular Science Monthly* 128: 29–32, 127. April, 1936.

This illustrated article describes one of America's most rapidly growing means of travel and abode of living—the luxury trailer. It is estimated that there are a million people utilizing 250,000 trailers as living quarters as they move about seeing America at first hand. It is estimated that another three years will see a million of these trailers on the road. —C.M.P.

MASON, GREGORY. "Native American Food." *Natural History* 37: 309–318; April, 1936.

The article discusses the contribution of America to the foods of the world. These foods include: pineapple, strawberry, tomato, potato, corn (maize), tobacco, sweet potato, lima bean, pumpkin, turkey, tapioca, and also sugar cane, coconut, and banana. —C.M.P.

HARRINGTON, JEAN. "Why Does the Atom Stick Together?" *Scientific American* 154: 80–82; February, 1936.

This question not only puzzles the layman who has a little smattering of knowledge of the structure of matter, but it also puzzles the scientist. Stability of atoms seem to depend on the ratio of protons and neutrons present (if neutrons actually exist). The answer is not known at the present time. —C.M.P.

STEVENS, CAPT. ALBERT W. "Man's Farthest Aloft." *The National Geographic Magazine* 69: 58–59; January, 1936.

This is a description of the stratosphere flight of November 11, 1935, which reached a record height of 13.71 miles. Illustrated. —C.M.P.

PORTER, LAWRENCE C. "Electrical Floriculture." *Scientific American* 154: 133–135; March, 1936.

Artificial light is being used to supplement daylight in growing plants in greenhouses and homes. It has been found that high lighting intensity is not necessary. —C.M.P.

HARDING, F. SWANN. "Vitamins Today." *Scientific American* 154: 117–120; March, 1936.

The present status of our knowledge of Vitamins A, B, C, D, E, F, G, H and K is discussed. The author advises that a person eat a varied and well-rounded diet, expose himself to sunshine now and then, and forget vitamin worries. —C.M.P.

Condon, E. U. "Artificial Radium." *Scientific American* 154: 5–8; January, 1936.

Irene Curie, daughter of the famous discoverer of radium, and her husband, F. Joliot, were awarded the 1935 Nobel Prize in Chemistry for being the first to discover that matter artificially may be made radioactive. The article describes recent research relating to atomic structure, the work of the Joliots and others in producing numerous radioactive materials, the biological implications of these new materials, and the possibilities of future important transformations in matter by the use of electrostatic machines of the Van de Graaff type. —C.M.P.

McFayden, Aubrey D. "Meet the Champion Inventors." *Popular Science Monthly* 128: 11–13; 104; January, 1936.

Since the death of Edison, who had 1099 patents, the leading patentee is John F. O'Connor with 949 patents, chiefly those relating to railway draft gearing. Elihu Thompson has 696; Carleton Ellis, 648, Henry Wood had 434 and John Hays Hammond, Junior, has 360. Hammond is the youngest of the more prolific patentees. The article describes some of the patents of these more prolific inventors. —C.M.P.

Damru, Frederick. "Mysterious Diseases Baffle Science." *Popular Science Monthly* 128: 26–27; 107; January, 1936.

This is a very interesting article describing some of the mysterious diseases that affect human beings and that all too often defy diagnosis. —C.M.P.

Freeman, Lloyd. "Man's Oldest Ally, the Dog." *The National Geographic Magazine* 69: 247–274; February, 1936.

This is the first of a series of articles on the oldest ally of man, the dog. This faithful friend has shared the work, exploration, and sport of mankind since cave-dwelling days. There are 33 portraits of the Terrier Tribe in color by Edward Herbert Miner. —C.M.P.

Pearson, T. Gilbert. "Thrushes, Thrashers, and Swallows." *The National Geographic Magazine* 69: 523–546; April, 1936.

This is the thirteenth article in a series describing the bird families of the United States and Canada. Robins, bluebirds, the hermit thrush, and the European nightingale are familiar members of a famous musical family. There are 42 paintings from life by that well-known bird painter, Maj. Allan Brooks. —C.M.P.

Anonymous. "The First Rocket Air Mail Flight." *Popular Mechanics Magazine* 65: 641–642, 152A–158A; May, 1936.

Although the flight of the "Gloria," America's first air mail rocket was less than half a mile, it is significant of future developments. While a rocket motor is simple, the chief difficulty is in finding a metal for the nozzle which will withstand the high temperatures generated, about 2,000 degrees centigrade. There are fuel problems which have yet to be met. There is also need for developing a mechanism that will have the low speeds desired near the earth's surface with the high speeds necessary for rocket efficiency once the stratosphere has been reached. Dr. Goddard, pioneer and leading rocket expert in this country, has a patent on such a combined airplane-rocket craft. —O. E. Underhill.

Harrar, Norman J. "The Lost Art of Hardening Copper." *Scientific Monthly* 42: 142–150; February, 1936.

Of the many legends handed down on the lost arts of antiquity, none has been more persistent than that relating to the hardening of copper. Reference is made to that famous lecture of Wendell Phillips on the "Lost Arts," first delivered in 1838, and repeated over 2000 times in the next 45 years. Many claims have been made for discovering a process of hardening copper, but the fabulous fortune involved still awaits the discoverer. —C.M.P.

Anonymous. "Strange Facts about Power Age." *Popular Mechanics* 65: 712–715, 139A; May, 1936.

Many new developments are occurring which may profoundly influence our methods of producing and using power. Already the United States, it is estimated, does half of the world's work. New developments in the General Electric Company's laboratories may make possible direct current power transmission. Certain advantages of direct current have heretofore been outweighed by the one fact that its voltage could not be easily raised and lowered, a requirement made necessary for the economic transmission of power over long distances without too high a loss due to heat. The transformer is at present an indispensable part of power transmission and it operates only on alternating current. The invention of such vacuum tubes as the thyratron and phanatron eliminate many of the difficulties which heretofore have prevented direct-current transmission on a commercial scale. With direct current the operators in the power distributing centers have much more flexible control. Synchronization becomes unnecessary and short circuits cause a drop in power flow rather than an increase. It would be possible to unite the whole United States into one great power pool. Power would be generated as A.C., converted to D.C. for transmission, and reconverted to A.C. for use. The remainder of the article summarizes the various possible energy sources of the world as given by Dr. Gustave Egloff, and elaborated by him in an article in the April issue of *Scientific Monthly*, 1936. —O. E. Underhill.

MAGEE, W. H. "Modern Wonders of an Ancient Art." *Popular Mechanics* 65: 809–816, 132A; June, 1936.

Enamel has served as a method of decoration for centuries. More recently its properties of resistance to acids, alkalies, heat, and abrasion have caused it to be used in a great variety of useful ways. It is now again coming into its own as a means of decoration. The architects have been the last to recognize that the same qualities which make it suitable for a bath tub, gas range or a refrigerator, also make it a suitable covering for interior and exterior walls as well as many kinds of furniture not now usually treated in this manner. This article describes the many ways in which enamels are now used—more ways than one would realize, tells how enamels are made and something of the chemistry involved, and suggests the future possibilities which are opening up for this material. —O. E. Underhill.

Anonymous. "The Mystery of Hotter and Colder." *Popular Mechanics* 65: 684–686, 144A; May, 1936.

This article brings together a number of interesting facts ranging from absolute zero to the temperatures of the hottest stars. There are at present about ten low temperature laboratories scattered through the world. One at Leyden, Holland, has reached within five-thousandths of a degree of absolute zero. Star temperatures have been estimated as high as forty million degrees. According to Jeans all temperatures less than seven and a half million degrees leave the total number of protons and electrons in a star unimpaired. Internal star temperatures have been estimated to be as high as five hundred million degrees. Bridgman's work at high pressures is discussed. He has produced varieties of ice both hotter and colder than normal. "Hot ice number 2" is hotter than boiling water. Many other interesting facts are given. —O. E. Underhill.

Anonymous. "The Age of Man-made Rubber." *Popular Mechanics* 65: 860–862, 140A; June, 1936.

One recently hears more and more about artificial rubber. Barely six years after the first commercial production of synthetic rubber in the United States, the industry now functions on a million-dollar scale. There are two synthetic rubbers produced in the United States, "thiokol" manufactured by the Thiokol Corporation and "duprene" by DuPont. A discussion of these two kinds of "man-made rubber" is presented. —O. E. Underhill.

CROWLEY, C. A. "Electroplating with Alloys." *Popular Mechanics* 65: 788–792; May, 1936.

Detailed directions are given for plating with cadmium-silver, "bronze," and brass. In the cadmium-silver plating the proportion of the two metals in the plate is controlled by regulating the current to each of the two anode bars separately. The so-called bronze is really a high copper brass. The anode may be a ten-per cent zinc brass, or alternate strips of copper and zinc, so arranged as to give ten times as much copper surface as zinc surface. All solutions must be made up exactly, and special methods of cleaning and in some cases pre-plating must be used to get results. —O. E. Underhill.

ESTABROOKS, G. H. "Your Brain." *Scientific American* 155: 20–22; July, 1936.

It is quite remarkable how much and how little the brain can stand. Often most of it can be removed without noticeable harmful effects, and again when only a minute part is affected either death or maladjustment occurs. The relation of delirium tremens, stroke, epilepsy, dementia praecox, opium visions, *etcetera* to the brain is discussed. —C.M.P.

Anonymous. "Weird Ways of the Wind." *Popular Mechanics* 65: 854–856, 120A; June, 1936.

Interesting facts about spots on the earth which have unusual wind conditions, especially in the North and South Polar regions.

—O. E. Underhill.

MARTIN, ROBERT E. "Marvels of Plant Breeding Produce Better Vegetables." *Popular Science Monthly* 128: 34–35, 128; May, 1936.

This article describes the work of experimenters working on scientific seed-farms to create new varieties of vegetables with greater eye appeal, increased food value and more disease resisting. Three of the most important of these experiment farms are located near Cleveland, Ohio; Salinas, California; and Paducah, Kentucky. —C.M.P.

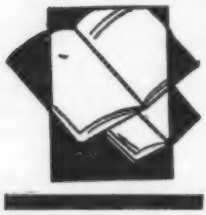
MARTIN, ROBERT E. "Weird Schemes to Make It Rain." *Popular Science Monthly* 129: 34–35, 115; July, 1936.

Many weird, fantastic schemes of rain-making have been devised, but none of them ever work. Several of these schemes are described in this interesting article. —C.M.P.

INGALLS, ALBERT G. "If You Smoke." *Scientific American* 154: 310–313, 354–355; June, 1936.

This article is by an associate editor of *Scientific American*. The article weighs the scientific evidence as to whether smoking is harmful. One experimental fact pointed out is that the evidence seems to be positive that di-ethylene glycol is less harmful than glycerine. "Most smokers—probably all smokers—are doubtless harmed to some extent, usually not great, by smoking" is the author's general conclusion. Most men smoke because tobacco is a mild sedative and quiets the nerves. —C.M.P.

New publications



LENT, HENRY. *Diggers and Builders.* New York: The Macmillan Company, 1935. 68 p. $1.50.

This little book for about the third-grade level contains very interesting material and excellent exercises. It deals with the experiences of Tony, the steam shovel man; Sam, the cement mixer; Dan, the derrick man; Joe, the steel worker; Pedro, the road builder; Bill, the truck driver. This is a reprint of the 1931 edition which has previously been reviewed. —O. E. Underhill.

LEAKEY, L. S. B. *Adam's Ancestors.* New York: Longmans, Green and Company, 1935. 244 p. $3.00.

During the past decade we have witnessed a rapidly growing interest in scientific findings pertaining to the origin and evolution of man. In this book Dr. Leakey has brought together the latest discoveries concerning the Stone Age. An account of what is known at present about our ancient ancestors is presented.

In the first part of the book the author shows how the mind of a modern prehistorian works; how he obtains guidance for his choice of excavation sites by sound deductive reasoning; how by applying scientific methods to his labors in the field and by correlating items of knowledge he makes deductions from the records left by primitive man.

This book is an up-to-date outline of what is known about the origin of man. It is written, largely, in the evolutionary way by tracing man's development from early primitive cultures up to the present time. An excellent chapter, called Apes and Man, answers the questions so often propounded by the laymen as to whether man is descended from a monkey. The last chapter, What of the Future?, is thought-provoking.

The book is written for popular consumption and it should find a wide reading public. The author evinces no small degree of optimism, however, when he assumes that the average laymen is already familiar with such words as Pleistocene and Pliocene. —E.D.H.

ELLSWORTH, LINCOLN. *Exploring Today.* New York: Dodd, Mead and Company, 1935. 193 p. $1.75.

This is an excellent book. All phases of exploration are covered. It is interesting reading, and emphasizes the scientific values of such work at all points. Rather long and excellently chosen quotations from the writings of such men as Roy Chapman Andrews, Harry L. Shapiro, Barnum Brown, and Margaret Mead are inserted. Explorations into the polar regions, beneath the sea, into the air and over the earth's surface are discussed. Archeological, paleontological and ethnological research, fields which have not yet been presented to any great extent in popular form, are not neglected. A list of chapter headings will suggest the wide scope of the book: The Lure of Exploration, Toward the Pole by Air, Exploring Today, Expeditions in South Seas, Paths That Lead to Exploration, Exploring Mountain Peaks, Exploring the Stratosphere, What is here Left to Explorers?, Fossils in the Grand Canyon, Moods of Mother Earth, Exploring the Bottom of the Sea, Digging for Dinosaurs, Women in Exploration, Exploring with Mechanical Eyes and Ears, Photographing Birds and Their Song, Fitness Essential in Exploration, Books Dealing with Exploration, Definitions. The definitions are of the various specialized fields of science which are developed largely through researches of an exploratory type. The reviewer was surprised to learn the extent of Ellsworth's experience in other fields of scientific explorations before he became famous as a polar explorer.

—O. E. Underhill.

BROWN, EMERSON C. *My Animal Friends.* New York: Blue Ribbon Books, Inc. 262 p. $1.00.

This book contains much interesting material about animals, derived from the author's experience as director of the Philadelphia Zoological Garden. It is more than mere animal stories. It seems to the reviewer, however, that the author is a bit too enthusiastic here and there with regard to the sagacity of some of the animals he describes. Of course, the line between intelligent behavior and instinctive reaction is sometimes hard to define. One of the most interesting and impressive parts of this book, was the picture the author presented of the problems in feeding a variety of animals in captivity. Special grass shipped daily from Florida for the manatee; a bucket of potatoes, twenty quarts of rolled oats, four heads of cabbage, fifty-two pounds of hay as a daily diet for the hippopotamus; and especially imported ant eggs from Africa. The chapter on Feeding our Guests gives many more such interesting facts. —O. E. Underhill.

SHEARER, M. H. Laboratory Exercises in High School Geography. Columbia, Missouri: Lucas Brothers. 1935. 122 p.

Evaluated as a workbook this seems to be an excellent piece of work. The reviewer, not being a specialist in geography, is not competent to express opinions on the nature of the material covered. The arrangement of the exercises seems to be such as would reduce to a minimum mere blank-filling. A large number of blank maps, data forms, coordinate rulings, *etcetera*, are provided for the development of the exercises. The workbook is divided into two sections: Part I, Physical Geography, and Part II, Economic Geography. Part I includes ten exercises on the globe, navigation, time, *etcetera*, 18 on topographic and geological features, 10 on the atmosphere and weather, and five on ocean currents, tides, *etcetera*. Part II devotes 18 exercises to such matters as regional economics, transportation, natural resources, population studies *etcetera*, and 12 exercises to international trade. This manual should meet the needs of a full-year high-school course in physical and economic geography. —O. E. Underhill.

ASHBROOK, FRANK G. *Furry Friends*. Racine, Wisconsin: Whitman Publishing Company, 1930. 22 p. $0.15.

This book is made up of large colored drawings of each of twenty-two wild North American mammals in its native setting, accompanied by well-written material on the size, description, habitat, habits, economic importance of each animal. It is an attractive book and is useful as a picture book for primary children in connection with the identification of wild animals in their own environment, and as a source book of information for older children. —L.M.S.

CARPENTER, FRANCES. *Our Little Friends of the Netherlands, Dirk and Dientje*. New York: American Book Company, 1935. 201 p. $0.72.

This is another of the family type supplementary geography readers for third or fourth grade. As usual the interest centers about boy and girl characters of the age of the readers. Again the sequence is seasonal, beginning in June and ending with tulip time in April. Colored drawings are an attractive feature.

To each of these later volumes a short glossary of terms has been added. This gives brief definitions, and pronunciations of difficult and strange names. —R.K.W.

WILLIAMS, LAWRENCE S. *Robin and Jean in Italy*. New York: American Book Company, 1934. 252 p. $0.72.

This is one of a series of travel books intended as supplementary readers for geography and history classes. It is suited to pupils of about fifth-grade level. It is distinctly more difficult than the Carpenter series of the same company reviewed elsewhere in this issue.

The stories of the various chapters revolve about the experiences of two American children touring Italy with their parents. Some of the chapters deal with the geography, home life, and industry of modern Italy. Others deal with historical material from ancient Rome. Illustrations for chapter headings are black and white drawings. Other illustrations are photographs. —R.K.W.

GARBEDIAN, H. GORDON. *Major Mysteries of Science*. New York: Covici-Friede, 1933. 348 p. $3.75.

This survey of the sciences gives a vivid picture of recent developments in science fields. A sufficient historical background is given to show the relation of the present to the past achievement. The reviewer feels, however, that the author is somewhat optimistic as to the social and economic effects of future scientific progress due to coming agricultural developments which enable the farmer to produce several crops a year " . . . Congress will no longer hold protracted bitter debates of the vexing problems of farm relief." Or again, "Man will be free from all back-breaking labor. Electricity will so shorten working hours that everyone will have all the leisure hours he wants . . . ."

Present trends toward agricultural surplus and decrease in man-hours per unit produced do not seem to be leading very speedily to the Utopia pictured. The book is divided into five parts: Problem of the Machine Age, The Story of Life, The Secrets of the Earth, The Challenge of Cosmic Problems, The Romance of the Skies. The numerous interesting slants given to the material tempt the reviewer to mention so many specific portions that it is probably wiser not to mention any. The book is well worth reading in its entirety. The typographical style is attractive. One wonders if there is a psychology or symbolism back of the method of printing numerals with the digits gradually increasing in size from 1 to 9. There are many fine full-page illustrations, although they are scattered with little relation to the content. It is disconcerting to come upon photographs of a panel of a dial telephone system, a steam turbine, huge generator parts, and so on, while reading Part II on The Story of Life. —O. E. Underhill.

FENTON, CARROLL LANE. *Along the Hill*. New York: Reynal and Hitchcock, 1935. 96 p. $1.25.

This is a John Day book, a companion book to *Along the Brook* and *Along the Shore*. It interprets geological phenomena, telling in simple words the story of the rocks, the soils, sands, shells, fossils, and of the geological processes going on in the hills around us.

A handy-sized book for field use, illustrated cleverly with pen drawings by the author, it makes an excellent book for beginning adults as well as for children in schools, camps, and nature study groups. —L.M.S.

Tobias, J. Carroll. *The Student's Manual of Microscopic Technique.* Boston: American Photographic Publishing Company, 1936. 210 p. $2.50.

This volume will be of great help to the student just beginning microscopic work. But at the same time it has much of value for the advanced student. It treats: the miscroscope; microscopic objects from water; killing and preserving; dissociation; section cutting; staining; mounting; preparing animal and vegetable materials; the polarizing microscope; accessories; photomicography.

There are seventy-nine illustrations.

—W.G.W.

Walker, Hattie Adell. *Read a New Story Now.* Chicago: Beckley-Cardy Company, 1935. 152 p. $0.70.

This is a book for the primary level, containing stories about seven particular animals. It is written from the point of view of the animals; the animals are named and converse together like people. The book is less valuable from this point of view and less interesting for children.

It is illustrated by attractive drawings in color.

—L.M.S.

Ransome, Arthur. *Winter Holiday.* Philadelphia: J. B. Lippincott Company. 350 p. $2.00.

This is an interesting juvenile story of the activities of a group of English children on a winter holiday. While very little actual science is presented, the story may serve as motivation to interest children in this field as one of the characters is quite an ardent amateur scientist.

—O. E. Underhill.

Carpenter, Frances. *Our Little Friends of Eskimo Land, Papik and Natsek.* New York: American Book Company, 1931. 239 p. $0.72.

This little volume is one of a series intended as supplementary readers in geography for third- and fourth-grade pupils. The print is of the large type typical of readers for these grades. The illustrations are drawings, chiefly in attractive bright colors.

The theme of the book is that of the home life and homely activities of an Eskimo family. The central characters for the young reader are Papik, an Eskimo boy, and his playmate Natsek, an Eskimo girl.

These volumes are recommended for the consideration of the grade teacher in making up library lists of geographic materials.

—R.K.W.

Carpenter, Frances. *Our Little Friends of the Arabian Desert, Adi and Hamda.* New York: American Book Company, 1934. 232 p. $0.72.

This is another volume in a series of supplementary geography readers for pupils in the third grade. The style is like that used by the author in other books of the series. The same type of attractive drawings in color are used as illustrations. This time the child hero and heroine are brother and sister. The stories concern the daily activities of an Arabian family set in a seasonal sequence. —R.K.W.

The Prognostic Value of University Examinations of Scotland. London: University of London Press Limited, 1936. 197 p. 5 shillings net.

This is a report of an inquiry into the prognostic value of examinations initiated by the International Institute of Teachers College, Columbia University. It gives many tables of marks, also *general deductions* and *individual subject deductions* on the following: arts and pure sciences, medicine. Finally, there is an interesting summary of conclusions. From this I quote one sentence: "There is no significant difference between the prognostic value of teachers' marks and that of the Department's marks for success either in the University class examinations or in the degree examinations."

—W.G.W.

Barraclough, F., and Holmyard, E. J. *Mechanics for Beginners.* New York: Oxford University Press, 1934. 214 p.

This book is one of the Dent's *Modern Science Series.* It has been written by English authors who state that in writing of this book they have aimed at a combination of simplicity with scientific accuracy.

The book has ten chapters. There is nothing particularly unique about the content of the book. The topics treated are about the same as those treated under "Mechanics" in an American high-school-physics textbook.

The style of writing deserves mention however. The major concepts of mechanics are developed in a clear, lucid and interesting manner. American authors of physical science textbooks might profitably study the manner in which physical concepts are developed in this book.

There are only ninety-two figures in the book. The manner in which the book is illustrated leaves much to be desired. —E.D.H.

Koeppe, Clarence E. *Weather and Climate.* Bloomington, Illinois: McKnight and McKnight, 1935. 135 p. $0.80.

This workbook presents a simple and comprehensive survey of weather science. In it are assembled many of the essential facts of weather and climate. More than sixty maps, charts and diagrams are included.

According to the authors the book is prepared primarily for students of geography. It has a threefold aim: (a) to supplement the preliminary or first year course in college geography; (b) to serve as a basis for college courses in weather and climate; and (c) to serve as a study guide for the many teachers of elementary or high-school geography, who find themselves inadequately equipped in the field of weather science. —E.D.H.

SCHACKELFORD, FREDERICK H. *Earth and Sky Trails.* San Francisco: Harr Wagner Publishing Company, 1934. 203 p. $1.00.

This reader gives a straightforward account of the science of earth and sky and is one of a series of science readers being published for use in the elementary schools of the West. Excepting for references to the weather of the Pacific Slope, and to the West as an ideal place for sky study, the material could be used equally well in elementary schools anywhere in the United States.

Theories as to the origin of the universe and of the earth, the age of the earth, its fossil history, the geologic structure of the earth, and the constant changes, earthquakes and volcanism, climate and weather, the atmosphere and the water on the earth, the heavenly phenomena: solar system, sun, moon, meteors and comets, eclipses, and the stars, comprise the contents of this book.

The book is well written, contains good illustrations, though somewhat sparse in quantity, and is adapted for use from the fifth grade on.

At the end of each chapter, designated as a unit, are teaching aids in the form of questions to answers, things to do, and supplementary references. —L.M.S.

WHITE, W. B. *Seeing Stars.* Cleveland: The Harter Publishing Company, 1935. 61 pages. $0.10.

This little book is suitable for the child or the adult amateur astronomer. Directions for locating the common constellations, with naked eye and with small telescopes, are given, along with clear diagrams. Various ones of the legends associated with the constellations, accompanied by illustrative drawings, are included, making the book interesting from the reading standpoint as well as a guide to the stars. Descriptive material on the sun, planets, the moon, meteors, spiral nebulae, and comets is also given, with a number of photographs. —L.M.S.

MACDONALD, ROSE MORTIMER ELLZEY. *Then and Now in Dixie.* Boston: Ginn, 1933. 293 p. $0.84.

This is a fusion of geography and history for Virginia boys and girls. It is written by a Virginia rural school supervisor. The geography is primarily concerned with the industrial development of the Old Dominion, especially with the industries dependent upon farming.

The narrative thread follows the adventures of Betty and Dick of Boston whose mother was born in Virginia. Uncle Richard of Virginia undertakes to acquaint them with his state during a long visit.

The book is well and attractively illustrated with photographs of modern Virginia industry and agriculture. At the end of each chapter are schoolish questions and tests. A reading list is also appended to each chapter. Even the adult reader will learn much of our oldest state in reading this volume. —R.K.W.

RICHARDS, IMAGARDE, and LANDAGUIRE, ELENA. *Children of Mexico, Their Land and Its Story.* San Francisco: Harr Wagner, 1935. 323 p.

The purpose of the book is to build a feeling of neighborliness and understanding in the boys and girls of the United States for the people in Mexico. The material seems adapted to grade levels from six to eight.

Each chapter is a complete story. Each of these is built around incidents in the lives of Mexican boys and girls of about the ages of the expected readers. The general material is both historical and geographical. The first story following the introduction deals with the life of an Aztec boy before the conquest and tells the story of the building of Mexico City. The other stories are in historical order. The later ones deal with present Mexican life and customs. There is an extensive appendix illustrated with maps, giving facts concerning Mexican geography. The book is well illustrated with both photographs and black and white drawings.

Teachers in the upper grades may well consider the inclusion of this book in preparing library lists for geography or history.

—R.K.W.

HOLMYARD, E. J. *Chemistry for Beginners.* New York: Oxford University Press, 1934. 223 p.

This volume written by an English scientist is one in the Dent's *Modern Science Series.* It has been written to introduce beginners to the science of chemistry. It is not comprehensive enough to have wide use as a chemistry textbook in American secondary schools.

The book is very interestingly written and should make a valuable reference book for general-science courses and a valuable supplementary edition for high-school-chemistry classes.

—E.D.H.

CONANT, JAMES BRYANT. *Organic Chemistry.* New York: The Macmillan Company, 1936. 293 p. $2.60.

This is a second edition of Conant's *Organic Chemistry* which is devised for a short introductory course in this field. It is the orthodox fashion to begin the study of organic chemistry with the hydrocarbons but in this revision there has been retained a novel feature of the first edition, namely, the introduction to the subject by means of the alcohols.

Mechanisms and theoretical interpretations such as the electronic theory are omitted from this edition. Such topics as industrial alcohol, petroleum, rubber, and the synthesis of compounds from ethylene and acetylene are treated at some length with the view to showing some interesting practical application of the science.

—E.D.H.

James, Preston E. *An Outline of Geography.* New York: Ginn and Company, 1935. 475 p. $3.00.

This book is an attempt by Professor James of the University of Michigan to describe the world systematically. It is based upon a course which has been given successfully for several years to beginning students in geography at the University of Michigan.

The book in the main consists of logical accounts of eight types of regions; dry lands, the tropical forest lands, the mediterranean scrub forest lands, the mid-latitude mixed forest lands, the grasslands, the boreal forest lands, the Polar lands, and the mountain lands. Each of these types of regions is described around the following headings: the Fundament (vegetation and climate), Surface Features, Occupance and Conclusion.

The book contains many original maps. The numerous physiographic diagrams by Raisz and the new colored maps of vegetation types are noteworthy. —E.D.H.

Jastrow, Joseph. *Wish and Wisdom.* New York: D. Appleton–Century Company, 1935. 394 p. $3.50.

For those interested in the occult, phrenology, mind reading, spiritualism, and the like, Dr. Jastrow has collected much interesting and instructive material relating to these crafts. The discussion is intellectual and discriminatory, but concrete, and narrative. He classifies his tales under credulity, magic and marvel, transcendence, prepossession, congenial conclusions, cults and vagaries, and rationalization, and characterizes all of them as man's wishes or desires which tend to lead him away from wisdom, or truth, or scientific reason.

A variety of illustrations adds interest and understanding. —A.W.H.

Fazzini, Lillian Davids. *Indians of America.* Racine, Wisconsin; Whitman Publishing Company, 1935. 96 p.

This pocket-sized book presents interesting facts about some of the better known Indian tribes of North America. It contains many colored illustrations which show the different costumes, ornaments and homes of the Indians. The book should be popular with boys and girls of scouting age. —E.D.H.

Bedell, Ralph C. *The Relationship Between the Ability to Recall and the Ability to Infer in Specific Learning Situations.* Buletin of the Northeast Missouri State Teachers College, Volume 34, No. 9, Kirksville, Missouri: Northeast Missouri State Teachers College, December, 1934. 56 p.

The specific problem of this investigation is stated as follows: What is the relationship between ability to recall and the ability to infer in specific learning situations when science materials are used as the situations? As such it is an aspect of the larger psychological problem of the relationship which exists between learning at the lower mental process level and learning at the higher mental process level. The study also seeks to solve two closely related but subsidiary problems, namely, (1) How are ability to recall and to infer related to intelligence as determined by a standardized intelligence test? and (2) How are the abilities to recall and to infer related to performance in science as measured by grades?

Tests for measuring ability to recall and ability to infer in science situations were constructed by the investigator. Unfortunately the tests, or samples of them, are not included in the monograph. These tests consisted of thirty paragraphs each of which presented certain facts from which could be inferred a science principle or generalization not stated directly in the paragraph, and each of which met certain other specificially stated criteria. Two sets of five questions were then prepared for each paragraph, the first set designed to measure the student's ability to recall stated facts and the second set designed to measure the student's ability select, from five possible conclusions to the paragraph, the correct principle or generalization suggested by the paragraph.

The tests were given to 324 boys and girls in eighth- or ninth-grade general science classes with a mean intelligence quotient of 107.9, as determined by the Terman Group Test of Mental Ability, Form A. The reliability of the recall and inference was such that the tests seemed to be adequate measuring instruments for the purposes of the study.

Through a carefu and clear treatment of the the data the investigator arrives at certain conclusions which appear to be valid and of great significance to the teacher of science. The conclusions further project the reader into a number of fundamental questions regarding the nature of the learnings at different levels in any subject field. A few of the conclusions are here given: (1) The bulk of the evidence in this study indicates that the ability to recall and the ability to infer, as they are here measured, are different abilities; (2) Evidence is presented which indicates that the subjects in the lower twenty-five per cent in inteligence have great difficulty in inferring, as that process is measured in this study; (3) Scores on the Factual Recall Section of the Bedell Test are approximately as closely related to scores on the Terman Test as are scores on the Inference Section of the Bedell Test; (4) The ability to infer enters into the ability to get marks in general science to a greater extent than either the ability to recall or the ability measured by the Terman Test; (5) It is possible to measure the ability to infer and the ability to recall in specific learning situations with a fairly high degre of objectivity.

—C.J.P.

Unit Studies in the Natural Sciences. Chicago: Follett Publishing Company. 1933. Eight pages each. $0.05.

The set consists of nine separate leaflets for general science in grades 7 and 8, or junior high school. Each study contains eight pages of material, arranged as follows: main problem; what we are trying to find out; four to ten separate problems with questions, experiments, field work indicated to help in the solution of each. At the end is a list of books to read, a teacher's outline, a list of books for the teacher.

The authors and titles of these unit studies are:

1. Mitchell, Harley W. and Mackintosh, Helen K.: *Animal Life Long Ago.*
2. Mitchell, Harley W. and McKelvey, Merle I.: *Animal Life Today.*
3. Mitchell, Harley W. and Putnam, Lucia G.: *Insects that Help and Harm.*
4. Mitchell, Harley W. and McSpadden, W. W.: *Life Under the Microscope.*
5. Mitchell, Harley W. and Graham, O. V.: *How Plants Live and Grow.*
6. Mitchell, Harley W. and Voorhees, Herbert S.: *Marvels of Heat, Light, and Power.*
7. Mitchell, Harley W. and Daugherty, Albert Lee: *What Things Are Made Of.*
8. Campbell, Edna Fay and Allan, Keith B.: *The Why and How of Weather.*
9. Mitchell, Harley W. and Preble, Charles S.: *How the Earth's Surface Changes.*

—L.M.S.

CLARK, B. F. and HENDRICKSON, GEORGE O. Nature Science Series. Chicago: Follett Publishing Company. Book I *Nature Study,* 1934, 32 p.; Book II *Nature Study,* 1931, 64 p.; Book III, *Elementary Science,* 1934, 32 p. $0.18 each.

These are paper covered notebooks intended for the elementary school. They are obviously intended as supplementary material to some course of study. Each page is devoted to a separate plant or animal with facts about it, an outline illustration to be colored with crayons, and a few simple questions to be answered by the pupil. In reality it is a succession of object lessons with no unifying scientific idea. With the exception of two lessons in Book III, one on *Star Study,* the other on *Expansion of Heat and Cold,* the lessons are devoted entirely to living things. —L.M.S.

KING, JULIUS. *Birds. Books I, II, and III.* Cleveland: The Harter Publishing Company, 1934. Each book has 62 pages. $0.10.

These inexpensive manuals are valuable for boys and girls of elementary school age who are interested in becoming acquainted with birds. In each book the following information is given about fifteen birds: length, order, family, scientific name, range, and a description of habits. A full-page colored picture is given for each bird. These pictures are reproductions of the excellent bird paintings by Allan Brooks and are used through the courtesy of the National Association of Audubon Societies. —F.G.B.

MALONEY, TOM and RITTASE, BILL. *Circus Days and What Goes on Back of the Big Top.* Philadelphia: Edward Stern and Company Inc., 1934. 24 p. $0.10.

The circus has come to town. This time in a book containing excellent photographs depicting the many activities of a circus from the time it begins to unload until all equipment is reloaded and ready to leave for the next big show. Accompanying each photograph is a short discussion explaining the picture. For the boy or girl who has watched a circus during its visit in a town, the book will recall happy circus experiences. To others, it will give an accurate idea of a day with a circus. The book will be enjoyed by boys and girls of elementary school age. It is one of a series of inexpensive books published by Edward Stern and Company. —F.G.B.

RITTASE, WILLIAM M. *A Day with "Mike" the Monkey.* Philadelphia: Edward Stern and Company, Inc., 1934. 24 p. $0.10.

In this story, Mike, a trained monkey and a pet of a little girl, tells the many interesting things he does during a day. He is a trained Capuchin monkey. Capuchin monkeys make excellent pets. They are intelligent, learn tricks easily, and seem to understand much that is said to them.

The book is beautifully and profusely illustrated by photographs showing Mike engaged in his various activities. The illustrations and story will delight children, and at the same time, give intimate acquaintance with a pet monkey. —F.G.B.

ROBERTS, H. ARMSTRONG. *Barney. The Story of a Wirehaired Foxterrier.* Philadelphia: Edward Stern and Company, Inc., 1934. 24 p. $0.10.

This is the story of a wirehaired foxterrier, the playmate of a seven-year-old girl. It tells how Joan selected her pet from a kennel in which there were many kinds of dogs for sale; the many escapades of a growing puppy; the tricks that Barney learned; and the many good times enjoyed on the sand dunes and at the beach.

The delightful book is profusely illustrated by beautiful photographs of Barney and his little mistress. While it is written primarily for children of third and fourth grades, the excellent pictures make it valuable for younger children. —F.G.B.

Sargent, Porter. *The New Immoralities.* Boston: Porter Sargent, 1935. 190 p. $2.00.

This is a series of brief esays expressing the author's personal philosophy of life. Most of the selections are less than a page in length. The point of view is that of the iconoclast. The tone is satirical, sometimes humorous. There is no single developed theme. Within the groupings adopted the arrangement is a random one.

This little volume will be enjoyed by some other iconoclasts, and probably overlooked by the conformists. It is a book to be dipped into occasionally, not one to sit down and read through. —R.K.W.

Butler, Alfred M. *Foundations of Physics.* New York: M. Barrows and Company, 1934. 613 p. $2.00.

This is a high school physics textbook replacing Household Physics by the same author. The content is organized in the traditional manner about the subjects heat, light, sound, magnetism, mechanics, electricity, and radio. The subject of heat is used as the beginning subject for study because the author believes that it is more easily understood by the average person.

The text is written in a clear and interesting fashion. It is apparent on reading the book that the author has kept in mind the experiences and interests of senior high school students. If more authors of high school physics textbooks would do this it is quite likely that physics would be elected more freely by high school students.

The book contains 507 line drawings and halftones which aid in clarifying the text. From an artistic standpoint, at least, there is room for much improvement in the illustrations.

The book is lacking in supplementary materials. No suggestions for demonstrations or experiments are provided. No references for supplementary reading are given. It should be mentioned, however, that excellent lists of questions and problems for thought and discussion are freely provided. —E.D.H.

Hoyt, Vance Joseph. *Bar-Rac: The Biography of a Raccoon.* Boston: Lothrop, Lee and Shephard Company, 1931. 111 p. $1.50.

This delightful book is the biography of a raccoon that was taken in infancy from her parents and raised in the home of the author for the purpose of scientific study. The author is an expert naturalist who knows intimately the life habits of Bar-Rac and of many of the wild folk of fields, woods, and desert. He is also a skilled story-teller.

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The excellent illustrations are photographs taken by the author. The book will be of interest to boys and girls of elementary school age as well as to adults, who are interested in wild animals. —F.G.B.

Caldwell, L. L. and McAtee, Veva. *20th Century Workbook in General Science.* Chicago: Follett Publishing Company. Book I, Grade 7, 1930, 125 p. Book II, Grade 8, 1930, 128 p. $0.36 each.

Each of these books presents a ten months' course for the specific grades indicated. Book I gives material arranged by months on trees, insects, weather, the heavenly bodies, light, the human body, seeds and soils, flowers, and birds. Book II has units on insects, weeds, flowers and seeds, rocks, machines, men of science, electricity, air, matter and energy, science in the home.

Factual material, directed study material, illustrations, things to do, experiments, space for students' notes, book references, testing material, vocabulary and spelling lists, constitute the form of the notebooks. At the end of the notebooks are given specific page references on each unit, taken from World Book, Encyclopedia, The New Human Interest Library, Compton's Pictured Encyclopedia, and the Book of Popular Science; general book references follow. —L.M.S.

Hamer, O. Stuart and Hamer, Anna M. *Our Farm Babies,* 133 p., and *Other Farm Babies,* 136 p. Bloomington: McKnight and McKnight, 1934. $0.80 each.

These constitute a two-book series of supplementary readers made up of interesting stories of farm animals and their babies. The reading material is built around the actual experiences of John, a real boy living on a farm. The usual farm animals: chickens, kittens, calves, lambs, puppies, colts, pigs, rabbits, turkeys, and honeybees form the material of the first book. Other animals: quail, cottontails, robins, fish, frogs, and squirrels, ponies, pheasants, pigeons, ducks, peacocks are described in story form in the second book. The material is accurate and interesting. The vocabulary is adapted for use in the second grade and above.

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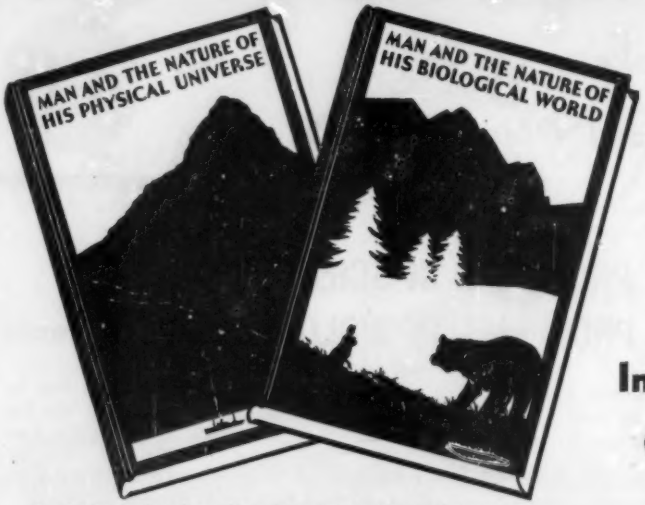

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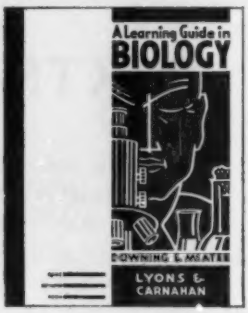

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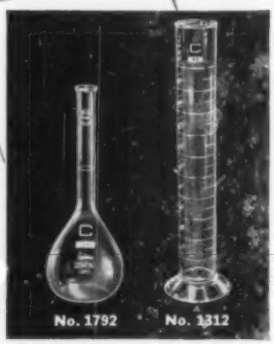

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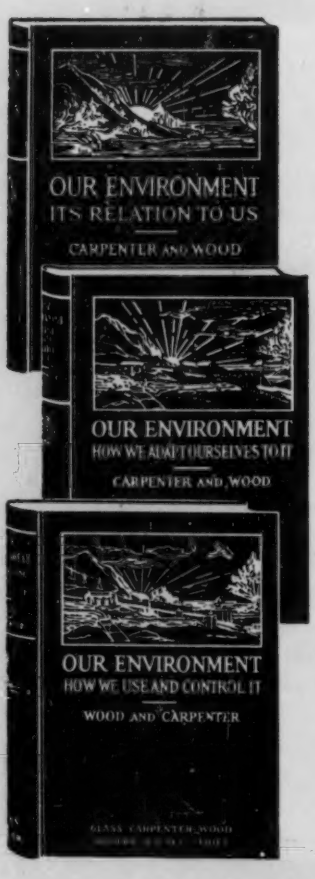
Social Responsibility

"PHILOSOPHY begins in wonder" is as true today as when Plato used these words.



The wonders of science are a bridge to a true philosophy of life. Tested truths and scientific thinking produce these wonders. They produce also tolerance—the withholding of judgment until the facts are determined—distrust of all superstition and of all conclusions which are not based on carefully determined facts.

It is easy to understand why children begin first to wonder, then to think straight, then to develop a true philosophy which influences their conduct, when they study the simple laws and principles which have developed the railroad, the telephone, the radio which brings the whole world within earshot just by the turn of a knob, the airplane with which we cross the continent overnight.

What events in history are as important as the great scientific discoveries of the past made in the midst of religious intolerance and social unrest, occupying a much smaller place in history than this intolerance and unrest but outweighing both in importance and indeed contributing toward putting an end to both?

Study and investigation help children to think straight. So science contributes abundantly to right thinking and conduct. As our children share in its teachings, we may expect them to learn increasingly those principles of open-mindedness and unselfish service which will make them tolerant and responsible members of society.

Allyn and Bacon

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